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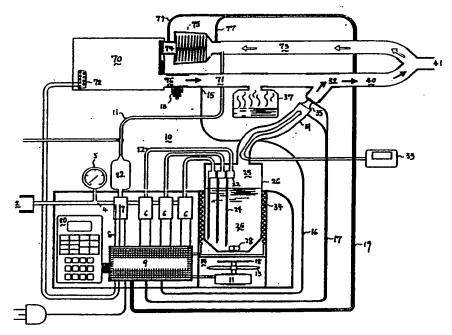
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(57) Abstract

A self-contained, high capacity nebulizer (10), having automatic mixing (28) and temperature control (34) features is provided. The nebulizer is designed for use in conjunction with mechanical respirators (70), ventilators, or breathing machines, and for this purpose will use electrical signals (8) generated by or received from the respirator (70) to automatically control and synchronize the nebulizing and mixing functions such that nebulization occurs only during the exhalation phase of the respiratory function to load the gas passageway of the respirator (70) to the patient with a standardized dose of medicinal aerosol. Upon commencement of the inhalation phase, the aerosol in the gas passageway is ventilated into the lungs of the patient to which it is attached.

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# INTERMITTENT SIGNAL ACTUATED NEBULIZER SYNCHRONIZED WITH EXHALATION

This application is a continuation-in-part of copending U.S. Patent Application Serial No. 07/585,616, filed on September 20, 1990, which is a continuation of U.S. Patent Application Serial No. 270,520, filed on November 14, 1988, now abandoned, which is a continuation of U.S. Patent Application Serial No. 07/071,202, filed on July 8, 1987, now U.S. Patent 4,832,012.

### Technical Field

The present invention relates to nebulizers for creating medicinal aerosols for inhalation therapy. In particular, the present invention relates to nebulizers used during the exhalation phase of the breathing cycle in conjunction with and without interfering with mechanical breathing machines which are used to ventilate the lungs of patients who cannot breathe unaided.

#### 20 Background Art

The thin membrane of the lungs provides an easily penetrated, convenient and generally safe means for obtaining rapid absorption of medication by the body. This is especially desirable where the lungs themselves are diseased or injured. Such medication or drugs are generally delivered to the lung membrane in the form of a fine mist or aerosol which is breathed into the lungs through the nose or mouth of the patient. A variety of devices, called nebulizers by those skilled in the art, have been developed for converting liquids into fine aerosols

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for this purpose. The simplest of these devices is the hand-held atomizer which converts a liquid to an aerosol when a bulb is compressed to produce a jet of air which atomizes the medication and propels it out of the atomizer. To be effective, the aerosols need to be provided at high concentrations and with droplet size in the respirable range (mass median aerodynamic diameter less than 3 micrometers).

Nebulizers are particularly useful for initiating and continuing respiratory therapy in conjunction with respirators, mechanical ventilators or breathing machines (hereinafter referred to generically as respirators) used to ventilate the lungs of patients having serious respiratory impairment. While some respirators incorporate nebulizers in their design, many do not. Nebulizers incorporated into the structure of such respirators often suffer from many disadvantages. One such disadvantage is severely limited capacity for medication to be nebulized, requiring frequent interruptions in the therapy as new medication is added to the nebulizer reservoir.

Most, if not all, such nebulizers are incorporated in respirators in which the inhalation and exhalation phases of the breathing cycle are triggered by changes in air pressure caused by the patient himself. Such "demand" respirators are not useful for patients whose respiratory systems are paralyzed and incapable of causing even slight changes in air pressure. These patients are aided by mechanical respirators in which the phases of the breathing cycle are triggered by electrical signals. There is now no effective means for patients on such respirators to receive aerosol treatment.

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Thus, the need exists for a nebulizer which can be attached to a mechanical respirator, especially those in which the breathing cycle is controlled by an electrical signal, which has a reservoir capacity sufficient to enable several hours of continuous treatment, which can prevent the settling of suspensions or mixtures without creating nebulization-destroying turbulence.

U.S. Patent 4,832,012 discloses the principal of signal actuated synchronization of nebulization for delivery of aerosolized medicine to patients whose breathing is supported or augmented by a mechanical In that reference, nebulization could respiratory. be effected during inhalation or exhalation, but the primary trust of that reference was to provide aerosols during the inhalation phase of the breathing cycle to mix with the inhalation tidal volume provided by the respirator, and in synchrony with the normal operation of the respiratory. However, it has been found that the addition of volume of gas to mix with the inhalation tidal volume provided by the respirator, may interfere with the normal operation of the respirator in certain operating modes, and the medicinal aerosol is diluted by the portion of gas delivered by the respirator.

### Summary of the Invention

The present invention is based upon the nebulization of medicine during and synchronized with the exhalation portion of each breath of the breathing cycle to fill the airline leading from the nebulizer to the patient with a standardized dose of medicinal aerosols that are delivered to the lung by the force of the flow of breathing gas (oxygenenriched air) delivered by the respirator during the

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inhalation portion of the breathing cycle. One advantage of this invention is that more concentrated standardized dose of aerosol is delivered to the patient with the first parcel of gas that enters the lungs for each breath during the inhalation process. In addition, the signal used to actuate the nebulizer may be obtained from the ventilator or from an independently generated signal established by the nebulization system utilizing the readily detected respiratory air line pressure or pressure drop across filter from exhaled gas flow. Also, certain safety monitoring features are incorporated into such a system to detect aerosol clogging of respiratory filters and prevent interference with the normal operation of the respirator.

The nebulization system of the present invention can be attached to or operated with a mechanical respirator utilizing either a breathing cycle electrical signal obtained from the respiratory or an independent electrical signal generated by the nebulizer system which detects and responds to the exhalation initiation of the respirator. synchronized signal actuated nebulizer system is designed to operate during the exhalation phase of the breathing cycle while treating a sick patient and efficiently providing, in the short time available, a medicinal aerosol in the appropriate and desired volume, concentration, and particle size distribution for deposition in the respiratory airways of the lungs. An important feature of such a system is that all of the aerosol is generated quickly (in about 1 second or less) and in a way that does not interfere with the control system of the respirator. nebulizer system has a reservoir of capacity sufficient to enable several hours of continuous

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treatment and with provision to prevent the settling of suspensions or mixtures without creating nebulization-destroying turbulence, and provides a precisely measured volume of medicinal aerosol generated during patient exhalation in a manner to reach the patient at the precise moment when inhalation begins.

In one embodiment, the present invention provides a nebulizer for use with mechanical respirators which use electrical signals to control the breathing cycle. The nebulizer of this embodiment uses the existing electrical signals from the mechanical respirator to synchronize aerosol generation to fill the gas passageway from the respirator to the patient during the exhalation cycle. Upon the initiation of the inhalation cycle, the aerosol is delivered from the gas passageway to the patient. Nebulization is obtained in this embodiment using the premixed oxygen-enriched air provided at high pressure to the respirator. Automatic temperature regulation and stirring of the liquid medication is optionally provided to preclude concentration change, separation or settling of the medication. Finally, a large volume reservoir is provided to eliminate the need for refilling during lengthy treatment protocols.

### Brief Description of the Drawings

Figure 1 is a schematic side view of a nebulizer of the present invention operationally attached to a mechanical respirator;

Figure 2 is a perspective view of the intermittent signal actuated system of the present invention.

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### Detailed Description of the Invention

Figure 1 shows a nebulizer apparatus 10 of the present invention operably connected to a mechanical respirator 70. The nebulizer apparatus 10 comprises, in a housing, compressed gas inlet 2, at one end of a compressed gas conduit 4, adapted to be connected to a compressed gas source at pressure indicated by gauge 5. Preferably this compressed gas source is the same source which is furnishing oxygen-enriched air to the respirator 70, and provides compressed air or oxygen mixture to the nebulizer ranging up to about 50 psig.

Compressed gas conduit 4 is connected at the other end to a first electrically operated nebulizer valve 7, and a plurality of second electrically operated nebulizer valves 6, all of which are substantially similar. Examples of such valves which have been found useful include the Honeywell Skinner K4M ultraminiature 4-way solenoid operated pneumatic valve and Numatics HS series 2-way solenoid operated valves. Three valves 6 are shown in Figure 1.

Nebulizer valves 6 and 7 are connected by a plurality of electrical lead wires 8 to a microprocessor 9 and are controlled by the microprocessor 9. The microprocessor 9 receives the signals from a signal source 72 on the respirator 70 which controls the inhalation/exhalation phase of the breathing cycle. The microprocessor 9 controls the valves 6 and 7 to provide for a safe and effective operation. Examples of signal source 72 include a respirator solenoid, such as a solenoid actuated inhalation valve, an external electronic monitoring system, or an electronic interface attached to a signal generator on respirator 70, such as an

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interface connected to a logic circuit in the respirator.

A control unit 80, whose control panel is shown in Figure 2, is connected to the microprocessor 9. The control unit 80 controls the functions of the nebulizing apparatus 10 of the present invention.

Each of the nebulizer valves 6 connects the compressed gas source 4 to nebulizer conduits 12 leading to aerosol nozzles 22. Each nebulizer valve 6 switches between two positions as electrical on/off signals are received. In the first position, during the exhalation phase of the respirator 70 when the electric signal is "on", a passageway is opened between compressed gas conduit 4 and nebulizer conduits 12 and remain open until the desired aerosol volume has generated or until the inhalation phase is initiated by the respiratory 70 as controlled by microprocessor 9. In the second position, when the electric signal is "off", the nebulizer conduits 12 are sealed off.

Nebulizer conduits 12 are attached at their other ends to aerosol nozzles 22, which include liquid feed tubes 24 extending into reservoir 26. Reservoir 26 includes magnetic stirring bar 28 which is located in the bottom of the reservoir. The liquid medicine contained in reservoir 26 is preferably kept at constant temperature by a reservoir heater or cooler 34.

A chamber 14 houses an AC motor 11 which rotates a cooling fan 13 and a magnet 18. The rotation of the magnet 18 causes the stir bar 28 to rotate to prevent sedimentation or separation of medicinal constituents.

The liquid medicine in the reservoir 26 is drawn via the liquid feed tubes 24 and is converted by the

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aerosol nozzles 22 into an aerosol having droplets with a mass median aerodynamic diameter less than about 3 micron. The aerosol is generated into the air space 25 above the reservoir 26. The aerosol generated in the air space 25 enters into an aerosol tube 31.

The temperature of the aerosol in the aerosol tube 31 is controlled by a temperature controller 33. In one embodiment, the temperature controller is simply an electric heater having a control unit. Within the aerosol tube 31 is also a neb-flow sensor 35. The neb-flow sensor 35 detects the amount of aerosol being delivered through the aerosol tube 31. The output of the neb-flow sensor 35 is supplied as a signal to the microprocessor 9 via neb-flow sensor pressure/vacuum lines 17.

The respirator 70 has an inhalation tube 71 and an exhalation tube 73. The inhalation tube 71 fluidically connects the respirator 70 to a patient and during the inhalation phase, breathing gas is supplied from the respirator 70 along the inhalation tube 71 into the respiratory tract of the patient. The aerosol tube 31 connects the air space 25 above the liquid 26 to the inhalation tube 71 at a In addition, a pop-off valve 13 nebulizer input 30. is also located in the inhalation tube 71. function of the pop-off valve 13 is to relieve any pressure which is generated to dangerous levels within the inhalation tube 71. It functions purely as an emergency safety valve. Finally, an airway pressure sensor 15 is also positioned in the The airway pressure sensor 15 inhalation tube 71. generates a signal which is also supplied to the microprocessor 9 via airway pressure monitoring line 16. A humidifier 37 whose output is water vapor

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mixed with the breathing gas is also connected to the inhalation tube 71.

The exhalation tube 73 fluidically connects the patient to the respirator 70. Located within the exhalation tube 73 is an exhalation filter 75.

Upstream from the exhalation filter 75, i.e., between the exhalation filter 75 and the patient is an upstream filter pressure sensor 77. Downstream from the exhalation filter 75, i.e., between the exhalation filter 75 and the ventilator 70 is a downstream filter pressure sensor 79. The upstream filter pressure sensor 77 and the downstream filter pressure sensor 79 each provide a signal which is supplied to the microprocessor 9.

The solenoid 7 is also connected to receive gas from the gas conduit 4 and is adapted to supply gas to a decay flow line 11 to the exhalation tube 73, upstream from the upstream filter pressure sensor 77. Thus, the solenoid 7, when activated, provides a stream of compressed gas which is supplied into the exhalation tube 73, between the patient and the upstream filter pressure sensor 77. The function of the decay solenoid 7 is also controlled by the microprocessor 9.

The operation of the nebulizer apparatus 10 of the present invention will be understood as follows. The practitioner first determines the amount of volume per breath of the standardized dose of aerosol which is to be generated by the apparatus 10 of the present invention which is to be supplied to the inhalation tube 71. The amount is entered on the control unit 80. The microprocessor 9 receives the signal and based upon its knowledge of the gas pressure from the compressed gas conduit 4, and the cross-sectional area of each of nebulizing nozzles

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22, the microprocessor 9 calculates the amount of time which the solenoids 6 would have to be activated in order to introduce the desired amount of aerosol into the inhalation tube 71. Alternatively, the signal from the neb-flow sensor 35 is used by the microprocessor 9 to turn off the nebulizer solenoids 6 when the desired charging volume has been generated.

When the mechanical respirator 70 begins the exhalation phase of the respiratory cycle, electrical signal 72 supplies the signal to the microprocessor 9. (As will be discussed hereinafter, a number of other signals are supplied to the microprocessor 9 to indicate the beginning of the exhalation cycle. These additional signals are used in the event the ventilator 70 cannot provide the electrical signal source 72 or is used as a safety backup to the electrical signal source 72.) When the mechanical respirator 70 begins the exhalation phase, the inhalation port 76 is closed. The exhalation port 74 is opened, opening the exhalation tube 73.

After the electrical signal source 72 generates the signal indicating the beginning of the exhalation phase, the microprocessor 9 activates the solenoids 6 to the three nebulizing nozzles 24. Thus, after the commencement of the exhalation phase, and after the detection of the electrical signal, maximum generation of the aerosol from the apparatus 10 commences and continues until the standardized volume or dose of aerosol has been generated. Compressed gas flows through the compressed gas conduit 4 into the three nebulizer conduits 12 and into the nozzles 22, which draw liquid via liquid feed tube 24 from the liquid reservoir 26. The aerosol is then generated and is supplied into the air space 25 above

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the reservoir 26. The aerosol generated in the air space 25 then enters into the aerosol tube 31 where the temperature thereof is controlled by the temperature controller 33. The aerosol then leaves the aerosol tube 31 and enters into the inhalation tube 71 through port 30. Generation of the standardized dose of aerosol fills the charging volume space 40 between the nebulizer input port 32 and the patient 41 in the inhalation tube 71. Any excessive aerosol will enter the exhalation tube 73 and return to the respirator 70.

During the exhalation phase, the pressure in the inhalation tube 71 is monitored by the airway pressure sensor 15 and is supplied to the microprocessor 9. This provides a safety signal to the microprocessor 9 to shut off the function of the aerosolization in the event pressure within the inhalation tube 71 builds to an excessive level or if inhalation begins. In addition, a mechanical safety pop-off valve 13 is provided wherein in the event the pressure in the inhalation tube 71 exceeds the pressure regulation of the pop-off valve 13, the valve 13 would automatically open relieving the pressure in the inhalation tube 71.

During the exhalation cycle, the respirator 70 continuously monitors the pressure on the exhalation tube 73. In order to provide for a smooth decay flow of gas entering into the exhalation tube 73 from the patient, and thereby simulating smooth exhalation reduction from the patient, the solenoid 7 is activated during the exhalation cycle. When the solenoid 7 is activated, the gas from the compressed gas conduit 4 fills a fixed volume chamber 82. The fixed volume chamber 82 has a calibrated orifice which is connected to the decay flow line 11 and is

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supplied to the exhalation tube 73. During the time period in which the aerosol is being generated, the fixed volume chamber 82 is filled with breathing gas to a predetermined pressure. At the end of the charging period, the compressed gas from the gas conduit 4 is turned off. The gas from the fixed volume chamber 82 is then allowed to flow in a decay manner into the exhalation tube through the orifice connecting the chamber 82 to the decay flow line 11. When the pressure in the fixed chamber 82 gradually reduces, the flow entering the decay flow line 11 simulates a natural first order decay.

Synchronous with the beginning of the exhalation cycle, the three nebulizing nozzles 22 are turned on simultaneously or one at a time to produce the desired charging volume during a portion of the exhalation period to allow the respirator 70 to maintain and/or support the patient's spontaneous breathing effort without interference from the charging flow.

When the respirator 70 begins the inhalation phase of the respiratory cycle, the electrical signal source 72 switches to an "off" position. In the "off" position, the respirator inhalation port 76 opens; the respirator exhalation port 74 is closed.

The solenoid valves 6 are controlled by microprocessor 9 when first, the desired standardized dose is reached (usually only takes a portion of the exhalation phase), or secondly when microprocessor 9 detects the electrical signal source 72 turn to an "off" position. In the first priority, the solenoids 6 can be turned off one at a time. In the second case, the solenoids 6 are turned off immediately to allow respirator 70 to begin the inhalation phase.

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The gradual turning off of the plurality of solenoids 6 generates a gradual pressure reduction and flow shaping that prevents spurious triggering of the respiratory ventilator 70 caused by rapid flow Because the aerosol generated by the apparatus 10 of the present invention fills the inhalation tube 71 between the nebulizer input 30 and the patient with the desired standardized volume or aerosol dose, when the ventilator 70 begins the inhalation phase and pushes the gas in the inhalation tube 71 into the respiratory tract of the patient, the aerosol in the charging volume space 40 would be the first gas pushed into the lungs of the patient. Thus, the medicine produced by the aerosol would be first delivered to the patient during the inhalation cycle.

The advantage of the apparatus 10 and method of the present invention is that generating the aerosol and introducing it into the charging volume space 40 during the exhalation phase means the aerosol is precharged in the inhalation tube. Further, the amount of aerosol in the charging volume space 40 can be metered or controlled by the microprocessor 9. In addition, the introduction of aerosol during the exhalation phase does not perturb the pressure of the gas from the respirator 70 delivered during the inhalation phase.

As previously discussed, the source of electrical signal 72 may not be provided by all ventilators 70. The upstream filter sensor 77 and the downstream filter sensor 79 each provides a signal via the exhalation filter sensor pressure/vacuum lines 19, the difference of which indicates the commencement of the exhalation phase. Thus, upon the immediate commencement of the

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exhalation phase, a pressure differential would be detected between the upstream filter sensor 77 and the downstream filter sensor 79, respectively. This pressure differential, supplied as a signal to the microprocessor 9, would indicate to the microprocessor 9 that the exhalation cycle has commenced. This signal can be used by microprocessor 9 to begin nebulization when no respirator electrical signal is available. Alternatively, the airway pressure sensor 15 supplies a signal to the microprocessor 9 indicating the beginning of the exhalation and also the beginning of the inhalation for control of the nebulization by microprocessor 9 when no respirator electrical signal is available.

In addition, there are many safety considerations with the apparatus 10 of the present invention. With the upstream and downstream filter sensor 77 and 79 respectively having an exhalation filter 75 therebetween, the condition of the exhalation filter 75 can be continuously checked. the apparatus 10 of the present invention is continuously used, and as the filter 75 becomes increasingly clogged, the pressure differential between the upstream filter sensor 77 and the downstream filter sensor 79 would increase. Alternatively, the loading/clogging of the exhalation filter can be detected using the airway pressure sensor 15 which supplies a signal to microprocessor 9 via line 16. This is because airway pressure during nebulization is a function of the resistance of the The filter loading/clogging can exhalation filter. be detected by the microprocessor 9 and can be signaled on the control unit 80 as an alarm that the exhalation filter 75 needs to be examined and/or changed.

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As previously discussed, the airway pressure sensor 15 provides an independent airway pressure measurement upstream to exhalation filter to monitor the patients safety. Finally, the control unit 80 can control the apparatus 10 to cause it to pause its operation. This provides an independent check on the respirator system 70. The control unit shown in Figure 2 provides for setting of charging volume, respirator selection (for different commercial respirators), heater temperature, nebulizer hold option, alarm test option, alarm reset, and alarm silence. Further, the control unit displays respirator selection, charging volume, alarm, warning, and caution, indication of exhalation filter loading, patient peak inspiratory pressure, heater temperature and nozzle gas pressure. Signals from the neb-flow sensor 35 are used to alarm if either inadequate charging volume is generated or if the nebulizer nozzle 24 malfunction in the "on" position. The microprocessor 9 provides yet additional safe and effective operation for the apparatus 10 of the present invention. In the preferred embodiment, the microprocessor 9 is an Intel 8751 available from Intel Corporation. A copy of the program, written in the assembly language, for execution by the microprocessor 9 is attached as Exhibit A.

```
STITLE SAMPLE SIGNALS AND CONTROL VISAN 9
                :SAMPLE VENTILATOR ANALOG SIGNAL AND
                PRESSURE AND FLOW SIGNALS FROM NEBULIZER
                :AND CONTROL 3 NEBULIZER VALVES.
                :CONTROL SERIAL INTERFACE WITH OPERATOR
                ; SWITCHES AND DISPLAYS.
                FLOTIM EQU 11 :TIME=2.25
000B =
               NOFLOTIM EQU 50 :TIME=108
0032 =
                FLO_TH EQU 45 :FLO 18LPM.0.14CMWC,0.17V,2DH
002D =
               NOFLO_TH EQU 140 :FLO 35LPM.1.12CMWC.0.5V,8CH
008C =
                PIP_THRESH SET 120*8/5+32 ;THR=4.4V,EOH,120CM
00E0 =
               FILTAWP_THRESH EQU 55 ;PRES=34CM,1.07V,37H
               FILTDP_THRESH EQU 141 :PRES=5.5CM,2.75V,8DH
0037 =
008D =
                PATINSP_THRESH SET 5*8/5 ; PEEP-AWP= 5 CM WC
0008 =
                TEMP_HI SET 80*2 ;UPPER LIM 80C, AOH
00A0 =
                FSEG
0000
                                   :BANKO
                ALTHAME R1.RVENT_SIG ; VENTILATOR SIGNAL
0001 =
                ALTNAME R2, RFLT_FLO ; EXH FILT DP SIGNAL
0002 =
                ALTNAME R3, RAW_PRESS ; AWP TAP AT VENT
0003 =
                ALTNAME R4, RNEB_FLO ; NEB OUTPUT DP
0004 =
                ALTNAME RS.RTEMP ; TEMP DEG C * 2
0005 =
                                  :VENTILATOR # SELECTED
                ALTNAME R6, RVENT
0006 =
                                   ;BANK1
                ALTNAME R1, RCHG_TIM ; NEB CHARGE TIME
0001 =
                ALTNAME R2, RDIV10 ; TIMER DIV BY 10
0002 =
                ALTNAME R3, RDIV5 ; TIMER DIV BY 5
0003 =
                ALTHAME R4, RON_TIM ; NEB FLOW ON TIME
0004 =
                ALTNAME R5, ROFF_TIM ; NEB FLOW OFF TIME
0005 =
                ALTNAME R6.RSIL_TIM ; AUDIO OFF TIME
0006 =
                ALTNAME R7.RHOLD_TIM ; NEB OFF TIME
0007 =
                ENDS
0000
                DSEG
0000
                LED1 DATA 23H : LED BANKS
0023 =
                LED2 DATA 26H
0026 =
                LED3 DATA 25H
0025 =
                CHG_VOL DATA 28H :HUNS DEC DISPLAY
0028 =
                DEC_HUN DATA 29H ":NUMBER FOR DISPLAY
0029 =
                DEC_TEN DATA 2AH
002A =
                DEC_ONE DATA 2BH
002B =
                FLTLD_HUN DATA 2CH ; FILTER LOAD SETTING
002C =
                FLTLD_TEN DATA 2DH : 25%, 50% DR 75%
002D =
                FLTLD_ONE DATA 2EH
0025 =
                THREE_CYCLE DATA 2FH : THREE BREATH COUNTS
002F =
                FLTFLO_LO DATA 40H : RUNNING AVG CALC
0040 =
                FLTFLO_AVG DATA 44H
0044 =
                CLOG_LO DATA 45H
0045 =
                CLOG_HI DATA 46H
0046 =
                AWP_LO DATA 48H
0048 =
                AWP_AVG DATA 4CH
004C =
                AWP_MAX DATA 4DH
004D =
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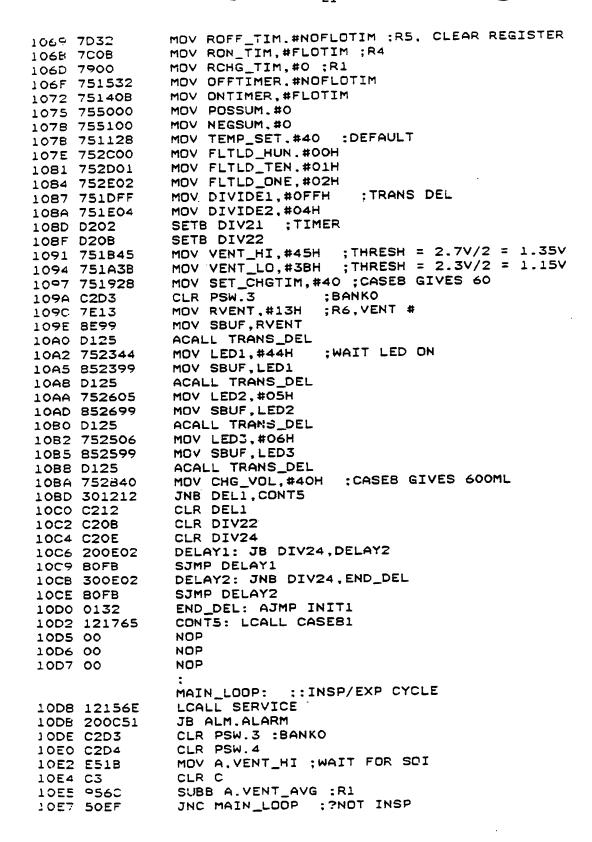
EXHIBIT A

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0051	=	NEGSUM DATA 51H ; NEB NEG SUM
0055	=	The second of th
0056	=	FLTLD50 DATA 56H
0057	=	FLTLD75 DATA 57H
0058	=	PIP_LO DATA 58H
005B	=	PIP_AVG DATA 5BH
0060	Ξ	PEEP_LO DATA 60H
0063	=	PEEP_AVG DATA 63H
0011	=	TEMP_SET DATA 11H
0012	=	TEMP_DEC DATA 12H
0014	=	ONTIMER DATA 14H
0015	=	OFFTIMER DATA 15H
0019	=	SET_CHGTIM DATA 19H ;CONTROLS CHARGE VOL
001A	Ξ	VENT LO DATA 1AH - LOWER THRESH
001B	=	
001C	=	TEMP_STORE DATA 1CH ; TEMPORARY STORE
001D	=	DIVIDE1 DATA 1DH ;TRANS_DEL
001E	=	DIVIDE2 DATA 1EH
0068	=	VENT_LOW DATA 68H
0060	Ξ	VENT_AVG DATA 6CH
0028		ENDS
		;
0000		BSEG
0000	=	WAIT BIT OH ; FIVE BREATH WAIT
0001	=	EXH BIT 1H ; EXHALATION PERIOD
0002	=	DIV21 BIT 2H ;TIMER
0003	Ξ	VOL_CHG BIT 3H ; OP CHANGING VOL SET
0004	=	VEN_SEL BIT 4H ; OP SELECTING VENTILATOR
0014	=	BEEP BIT 14H ;AUDIO ON/OFF
0006	=	SIL BIT 6H ; TWO MIN SILENCE
0007	=	SPON_BR BIT 7H ; PATIENT BREATH
0008	=	HOLD BIT 8H ; NEB OFF
0009	Ξ	SEE_PIP BIT 09H ;DISPLAY PIP
000B		DIV22 BIT OBH ;TIMER
0000	=	ALM BIT OCH ;AUDIO ALM SET
000D	=	OFF_ALM BIT ODH :BLINK_BEEP
0000		ALM_TST BIT OAH :SET DURING TEST
000E		DIV24 BIT OEH ;START DELAY
000F		FLOW BIT OFH ; NEB FLOW ON
0010		SEE_TEMP BIT 10H '
0011		SEE_LD BIT 11H
0012		DEL1 BIT 12H
0013		DEL_4TENTHS BIT 13H :TIMER
0015		INSP BIT 15H ; INSP TIME
0016		CLOG1 BIT 16H :COUNT FLT LD SAMP
0017		CLOG2 BIT 17H
0010		L14 BIT 1CH :LO BAT LED1
001D		L15 BIT 1DH ; FILTER CHANGE
001E		L16 BIT 1EH : WAIT 5 CYCLES
001F		L17 BIT 1FH ;LO FLOW
0034		L24 BIT 34H ; NO FLOW LED2
0035		L25 BIT 35H : NEB HOLD
0036	=	L26 BIT 36H :FILT CLOG

```
L27 BIT 37H : CONT FLOW
0037 =
               L34 BIT 2CH :HI PRESS
                                          LED3
002C =
               L35 BIT 20H :HI TEMP
0020 =
               DIV23 BIT 38H :TIMER
0038 =
               CLK BIT 39H ;TIMER 0.2S
0039 =
               HEAT BIT 3AH : HEATER ON
003A =
               TEMP BIT 3BH
003B =
               ENDS
0025
               CSEG
0000
               ; MACRO DEFINITIONS
                                    :ANALOG-DIGITAL CONVERSION
               ANALOG MACRO SAVE
               NOP : DELAY TIME FOR MUX
               NOP
               NOP
               NOP
               NOP
               CLR P2.3 ;START CONVERSION
                    :ALLOW CONV. TIME 5 MICROSEC
               NOP
               NOP
               NOP
                              ;SAVE DIGITAL OUTPUT
               MOV SAVE,P1
               SETB P2.3
               ENDM
               ;
               RUNNING_AVG MACRO LODATA, N. INSIG, AVG
               CALCULATES RUNNING AVERAGE OF N BYTES IN DATA MEMORY
               WITH A LOW ADDRESS OF LODATA. INPUT SIGNAL IS LOCATED
               :AT INSIG. AVERAGE OUTPUT IS AT AVG.
                PUSH PSW
               PUSH ACC
               PUSH B
                CLR PSW.3 ;BANKO
                CLR PSW.4
                MOV A. #LODATA ; SET RO
                ADD A,#N
                DEC A
                MOV RO,A
                NEXT1:
                DEC RO
                            :SHIFT UP
                MOV A, @RO
                INC RO
                MOV GRO.A
                DEC RO
                CJNE RO, #LODATA, NEXT1 : LODATA ADDRESS
                MOV A.INSIG ; MOV NEW DATA TO LODATA
                MOV B,#N
                DIV AB
                MOV @RO.A
                MOV A, #LODATA : ADD TG CALC AVG
                ADD A.#N
                DEC A
                MOV TEMP_STORE.A
```

MOV A, GRO XCH A,RO NEXT2: XCH A.RO INC RO ADD A. @RO XCH A.RO CJNE A.TEMP\_STORE.NEXT2 XCH A.RO MOV AVG, A POP B POP ACC POP PSW ENDM FIFO MACRO NEW\_IN, N1. NEW\_DATA REGISTER STORES SUCCESSIVE DATA FIFO ;FROM NEW\_DATA SOURCE INTO REGISTER ADDRESS :NEW\_IN.  $\overline{ ext{N1}}$  is the number of data stored. :BANKO CLR PSW.3 CLR PSW.4 MOV A, #NEW\_IN ; SET RO ADD A,#N1 DEC A MOV RO.A NEXT3: DEC RO ;SHIFT UP MDV A. @RO INC RO MOV @RO,A DEC RO CJNE RO, #NEW\_IN.NEXT3 ; NEW\_IN ADDR MOV NEW\_IN, NEW\_DATA ENDM BINARY\_BCD MACRO HUN, TEN, ONE CONVERTS BYTE LOCATED IN ACC TO DECIMAL ; AND STORES RESULT IN HUN, TEN AND ONE. :CLEAR REGISTERS MOV HUN,#0 MOV TEN,#0 MOV ONE,#0 CALC\_HUN: ;:SUBTRACT 100 MOV B.A **NEXTSUB1:** CLR C SUBB A.#100 JC CALC\_TEN INC HUN MOV B.A : SAVE SJMP NEXTSUB1 CALC\_TEN: ::SUBTRACT 10 MOV A.B NEXTSUB2: CLR C SUBB A,#10 JC CALC\_ONE

```
INC TEN
               MOV B.A
               SJMP NEXTSUB2
               CALC_ONE:
               MOV ONE, B
               MOV A, HUN
               JNZ BCD_OUT
                              :BLANK
               MOV HUN. #OFH
               MOV A, TEN
               JNZ BCD_OUT
                              ;BLANK
               MOV TEN, #OFH
               BCD_OUT:
               ENDM
               ORG 1000H
1000
                ; %5
                BEGIN:
                AJMP INITIALIZE
1000 0130
               DRG 1003H : MANUAL SWITCH INT.. INTO
1003
               LJMP MAN_SW
1003 0219CC
                DRG 100BH ;TIMER 0 INT., TFO
100B
                AJMP TIM_SAMP
100B 61F3
               ORG 1013H : LOW BATTERY INT., INT1
1013
                CLR IE1
1013 C288
                SETB L14
1015 D21C
                MOV SBUF, LED1
1017 852399
                ACALL TRANS_DEL
101A D125
                RETI
101C 32
                ORG 1030H
1030
                INITIALIZE: ;:SET REGISTERS
                SETB DEL1
1030 D212
                INIT1:
                ANL PCON, #OOH ; SMOD = 0
1032 538700
                MOV TMOD. #00100000B; TIME 1 MODE 2, TIME 0 MODE 0
1035 758920
                MOV SCON, #01010000B ; SERIAL PORT MODE 1
1038 759850
                             ;SET TIMER
                MOV THO, #70H
103B 758C7C
                MOV TH1, #OFDH ; BAUD RATE 9600
103E 758DFD
                MOV P2,#78H ; OUTPUTS OFF
1041 75A078
                             ; ENABLE EX1, ETO, EXO
                MOV IE,#87H
1044 75A887
                            :FIRST PRIORITY TIMER O
                MOV IP,#02H
1047 75B802
                MDV TCON. #50H :TIMERS ACTIVE, IT1 & IT0
104A 758850
                               ;LOW LEVEL TRIGGGER
                MOV PO .-#00H-
104D 758000
                MOV SP,#30H ; STACK ADDRESS
1050 758130
                MOV 20H, #00H ; CLEAR BITS
1053 752000
                MOV 21H, #00H
1056 752100
                MOV 22H, #00H
1059 752200
                MOV 27H, #00H
1050 752700
                                ;BANK1
                SETB PSW.3
105F D2D3
                                ;R3
                MOV RDIV5.#5
1061 7BC5
                MOV RDIV10,#10 :R2
1063 7A0A
                MOV RSIL_TIM,#120 :R6,DEL 2 MIN (3CH)
1065 7E78
                MOV RHOLD_TIM,#120 :R7
1067 7F78
```



10Eº D215	SETB INSP
10EE 200C3E 10F1 E51A 10F3 C3	JC EOI ;?NOT EOI
10FC C2D4 10FE 7900	MOV RCHG_TIM, #OOH ;R1 CHK EXH: ::FIND AWP PEAK & DROP
1105 401B	MOV A.AWP_MAX CLR C SUBB A.AWP_AVG JC DELAY5 ;?AWP MAX > AWP AVG CHK_AWP: ::CHK AWP DROP MOV B.A ;SAVE
1108 C3 110C 9563 110E 4007	MOV A, AWP_MAX CLR C SUBB A, PEEP_AVG ; AWP MAX - PEEP JC SET_EXH ; AWP <peep #5<="" a,="" ab="" div="" subb="" td=""></peep>
1117 D201	SUBB A,#5 JC SET_EXH ;?DROP 20% AJMP DELAY5 SET_EXH: SETB EXH MOV PIP_STORE,AWP_MAX ;NEW PIP MOV AWP_MAX.#0 ;RESET AJMP CHK_PEAK
1126 7432	NOP DELAYS: ::WAIT 0.5S SETB PSW.3 :BANK1 CLR PSW.4 MOV A,#50 CLR C SUBB A.RCHG_TIM JNC CHK_EXH ;?NOT 0.5S NOP NOP
112F D20C 1131 43A070 1134 200605 1137 200802 113A D2A7 113C D200 113E D21E 1140 852399	ALARM: SETB ALM ORL P2,#01110000B ;OFF VALVES CHK_SIL: JB SIL.CONT JB HOLD,CONT SETB P2.7 :BUZZER ON CONT: SETB WAIT SETB L16 :WAIT MOV SBUF.LED1

```
ACALL TRANS_DEL
1143 D125
1145 12156E
                LCALL SERVICE
1148 200CE9
                JB ALM, CHK_SIL
114B 752F00
                MOV THREE_CYCLE,#0
                AJMP MAIN_LOOP
114E 01D8
                CHK_PEAK: ;:PRESS LIMIT 120 CM
                JB WAIT, CALC_PIP
1150 20000A
                MOV A, PIP_STORE
1153 E54E
                CLR C
 1155 C3
                SUBB A.PEEP_AVG
1156 9563
                CLR C
1158 C3
                SUBB A, #PIP_THRESH
1159 94E0
                JNC HIPRESS
115B 5046
                CALC_PIP:
                RUNNING_AVG PIP_LO,3,PIP_STORE,PIP_AVG
115D
                ; CALCULATES RUNNING AVERAGE OF 3 BYTES IN DATA MEMORY
                ; WITH A LOW ADDRESS OF LODATA. INPUT SIGNAL IS LOCATED
                ;AT INSIG. AVERAGE OUTPUT IS AT AVG.
+115D CODO
                PUSH PSW
                PUSH ACC
+115F COEO
                PUSH B
+1161 COFO
                CLR PSW.3 :BANKO
+1163 C2D3
                CLR PSW.4
+1165 C2D4
                               :SET RO
+1167 7458
                MOV A. #PIP_LO
+1169 2403
                ADD A,#3
                DEC A
+116B 14
+116C F8
                MOV RO,A
                NEXT10001:
+116D 18
                DEC RO
                             ;SHIFT UP
+116E E6
                MOV A, @RO
+116F 08
                INC RO
+1170 F6
                MOV @RO,A
                DEC RO
+1171 18
                CJNE RO. #PIP_LO.NEXT10001 :LODATA ADDRESS
+1172 B858F8
                MOV A.PIP_STORE ; MOV NEW DATA TO PIP_LO
+1175 E54E
+1177 75F003
                MOV B.#3
+117A 84
                DIV AB
                MOV @RO.A
+117B F6
                MOV A. #PIP_LO ; ADD TO CALC PIP_AVG
+117C 7458
+117E 2403
                ADD A,#3
+1180 14
                DEC A
                MOV TEMP_STORE,A
+1181 F51C
                MOV A, @RO
+1183 E6
                XCH A.RO
+1184 C8
                NEXT20001:
+1185 C8
                XCH A.RO
+1186 08
                INC RO
+1187 26
                ADD A,@RO
+1188 C8
                XCH A.RO
                CJNE A, TEMP_STORE, NEXT20001
+1189 B51CF9
                XCH A.RO
+118C C8
+118D F55B
                MOV PIP_AVG.A
+118F DOFO
                POP B
+1191 DOEO
                POP ACC
```

POP PSW

```
+1193 DODO
                NOP
1195 00
                NOP
1196 00
                NOP
1197 00
                JB WAIT.STRT_EXH
1198 200013
                JB HOLD, STRT_EXH
 119B 200810
                                     ON VALVES
                ANL P2,#10001111B
119E 53A08F
                AJMP STRT_EXH
11A1 21AE
                HIPRESS:
                          ;HI PRESS
                SETB L34
11A3 D22C
                MOV SBUF, LED3
11A5 852599
                ACALL TRANS_DEL
 11A8 D125
                NOP
11AA 00
                ALARM1: AJMP ALARM
 11AB 212F
                NOP
 11AD 00
                STRT_EXH:
                                      :BANK1
                SETB PSW.3
 11AE D2D3
                 CLR PSW.4
 11B0 C2D4
                                      :R1,RST CHARGE TIME
                MOV RCHG_TIM, #00H
 1182 7900
                 CHARGE:
                                        :BANK 0
                 CLR PSW.3
 11B4 C2D3
                 LCALL SERVICE
 1186 12156E
                 JB ALM.ALARM1
 11B9 200CEF
                                   :VENTILATOR INSPIRATION?
                 MOV A, VENT_HI
 11BC E51B
 11BE C3
                 CLR C
                 SUBB A, VENT_AVG
 11BF 956C
                                     ; ?NO VENT INSP1
                 JNC CHK_CHGTIM
 11C1 5023
                                    OFF VALVES
                 ORL P2,#01110000B
 11C3 43A070
                 CHK_VOL: SETB PSW.3 ;BANK1
 11C6 D2D3
                 CLR PSW.4
 11C8 C2D4
                 JB WAIT, CHK_WAIT1
 11CA 200016
                 MOV A, SET_CHGTIM
 11CD E519
                 CLR C
 11CF C3
                 SUBB A, RCHG_TIM ;R1
 11D0 99
                 JC CHK_WAIT1 ;: VOL>SET
 11D1 4010
 11D3 F5F0
                 MOV B.A
                 MOV A.SET_CHGTIM
 11D5 E519
                 DIV AB
 11D7 84
                 SUBB A,#10
 11D8 940A
                 JNC CHK_WAIT1
 11DA 5007
                 SETB L17 :LO FLOW LED
 11DC D21F
                 MOV SBUF.LED1
 11DE 852399
                 ACALL TRANS_DEL
 11E1 D125
                 CHK_WAIT1: AJMP CHK_WAIT
 11E3 6108
 11E5 00
                 NOP
                 CHK_CHGTIM:
                                   ;SET VOLUME REACHED?
                 MOV A.SET_CHGTIM
 11E6 E519
                                    :BANK1
                 SETB PSW.3
 11E8 D2D3
                 CLR C
 11EA C3
                 SUBB A.RCHG_TIM :R1
 11EB 99
                 JNC CHARGE : ? VOL < SET VOL
 11EC 50C6
                                       OFF VALVES
                 ORL P2.#01110000B
 11EE 43A070
```

	•
11F1 20004B	JB WAIT, CHK_EOEXH1
11F4 101629 11F7 301728 11FA C217 11FC E544	JBC CLOG1,FIRST_SAMP :MEAS FLT LD SAMP JNB CLOG2,FLT_LD CLR CLOG2 :SECOND SAMPLE MDV A.FLTFLO_AVG
11FE 2545 1200 F546	CLR CLOG2 :SECOND SAMPLE  MDV A.FLTFLO_AVG  ADD A.CLOG_LO  MDV CLOG_HI,A ;UPPER LIM FILT CLOG  CLR C  RRC A ;DIV BY 2
1202 C3 1203 13 1204 F545 1206 C3	RRC A ;DIV BY 2 MOV CLOG_LO,A :LOWER LIM FILT CLOG CLR C RRC A ;HALF CLOG LO MOV B,A :SAVE
1207 13 1208 F5F0 120A 2545	RRC A ;HALF CLOG LO MOV B.A ;SAVE ADD A.CLOG_LO
120C F556 120E E5F0	MOV B,A ;SAVE ADD A,CLOG_LO MOV FLTLD50.A ;STORE 50% LEVEL MOV A.B CLR C
1210 C5 1211 13 1212 F5F0	CLR C RRC A ; ONE FOURTH CLOG LO MOV B.A ; SAVE ADD A.CLOG_LO MOV FLTLD25.A ; STORE 25% LEVEL
1218 E5FC	MOV A.B
121A 2556 121C F557 121E 4142	ADD A,FLTLD50 MOV FLTLD75.A :STORE 75% LEVEL AJMP CHK_DPTHRESH
1220 854445	FIRST_SAMP: ;:FIRST FLT LD SAMP MOV CLOG_LO,FLTFLO_AVG ;SAVE AJMP CHK_DPTHRESH
1225 E544 1227 C3	FLT_LD: ::SAVE FILT LOAD % MOV A.FLTFLO_AVG CLR C
1224 402F	SUBB A, CLOG_HI JC TEST75 SETB L26 ;FILTER CLOG LED
1233 752C10	SETB L26 ;FILTER CLOG LED  MOV SBUF, LED1  ACALL TRANS_DEL  MOV FLTLD_HUN, #10H ;SET FILTER LOAD 100%
1236 752B01 1239 752E02 123C 212F	MOV FLTLD_TEN.#01H MOV FLTLD_ONE,#02H AJMP ALARM
123E 00 123F 41A7 1241 00	NOP - CHK_EOEXH1: AJMP CHK_EOEXH NOP
1244 C3 1245 948D 1247 40F6 1249 D236	CHK_DPTHRESH: MOV A.FLTFLO_AVG CLR C SUBB A.#FILTDP_THRESH JC CHK_EDEXH1 ;BELOW THRESH SETB L26 :FILT CLOG LED MOV SBUF.LED2

124E D125	ACALL TRANS_DEL
1250 752010	MOV FLTLD_HUN.#10H
	MOV FLTLD_TEN.#01H
1253 752001	MOV FLTLD_ONE.#02H
1256 752502	
1259 212F	AJMP ALARM
	7507 75% CLOG
	TEST75: ;:TEST 75% CLOG
125B E544	MOV A.FLTFLD_AVG
125D C3	CLR C
125E 9557	SUBB A.FLTLD75
1260 4012	TC TEST50
1262 D21D	SETB L15 ;FILTER CHANGE LED
1264 852399	MOV SBUF, LED1
1267 D125	ACALL TRANS DEL
1267 D125	
1269 752070	MOV FLTLD_TEN,#71H
126C 752D71	MOV FLTLD_ONE, #52H
126F 752E52	AJMP CHK_DPTHRESH
1272 4142	TEST50: ;:TEST 50% CLOG
1274 E544	MOV A, FLTFLO_AVG
1276 C3	CLR C
1277 9556	SUBB A.FLTLD50
1279 400B	JC TEST25
127B 752CF0	MOV FLTLD_HUN, #OFOH
127E 752D51	MOV FLTLD_IEN,#310
1281 752E02	MOV FLTLD_ONE, #02H
1284 4142	AJMP CHK_DPTHRESH
	TEST25: ;:TEST 25% CLOG
1286 E544	MOV A, FLTFLO_AVG
1288 C3	CLR C
1289 9555	SUBB A,FLTLD25
128B 400B	JC TESTO
128D 752CF0	MOV FLTLD_HUN,#OFOH
1290 752D21	MOV FLTLD_TEN,#21H
1293 752E52	MOV FLTLD_ONE,#52H
	AJMP CHK_DPTHRESH
1296 4142	TESTO:
1000 750050	MOV FLTLD_HUN,#OFOH
1298 752CF0	MOV FLTLD_TEN.#OF1H
129B 752DF1	MOV FLTLD_ONE.#02H
129E 752E02	AJMP CHK_DPTHRESH
12A1 4142	
12A3 00	NOP
	ALARM2: AJMP ALARM
12A4 212F	
12A6 00	NOP
_	CHK_EDEXH:
12A7 12156E	LCALL SERVICE
12AA 200CF/	20 HEILLING
12AD C2D3	CLR PSW.3 ;BANKO
12AF C2D4	CLR PSW.4
1281 E518	MOV A, VENT_HI
1283 956C	SUBB A, VENI_AVG TRI
1283 956C 1285 503F	THE BAT INSP
1287 C201	OLD EVH FEND OF EXHALATION
1289	RUNNING_AVG PEEP_LO.3.AWP_AVG.PEEP_AVG
***	



```
:CALCULATES RUNNING AVERAGE OF 3 BYTES IN DATA MEMORY
                WITH A LOW ADDRESS OF LODATA. INPUT SIGNAL IS LOCATED
                ;AT INSIG. AVERAGE DUTPUT IS AT AVG.
                PUSH PSW
+12B9 CODO
                PUSH ACC
+12BB COEO
                PUSH B
+12BD COFO
                CLR PSW.3
                          :BANKO
+12BF C2D3
                CLR PSW.4
+12C1 C2D4
                MOV A. #PEEP_LO ;SET RO
+1203 7460
                ADD A,#3
+12C5 2403
                DEC A
+12C7 14
                MOV RO,A
+12C8 F8
                NEXT10002:
+12C9 18
                DEC RO
                MOV A. @RO
                              :SHIFT UP
+12CA E6
                INC RO
+12CB 08
                MOV @RO.A
+12CC F6
                DEC RO
+12CD 18
                CJNE RO, #PEEP_LD, NEXT10002 ; LODATA ADDRESS
+12CE B860F8
                                 :MOV NEW DATA TO PEEP_LO
                MOV A.AWP_AVG
+12D1 E54C
                MOV B.#3
+12D3 75F003
                DIV AB
+12D6 84
                MOV @RO, A
+12D7 F6
                MOV A, #PEEP_LO ; ADD TO CALC PEEP_AVG
+12D8 7460
                ADD A,#3
+12DA 2403
+12DC 14
                DEC A
                MOV TEMP_STORE, A
+12DD F51C
                MOV A, eRO
+12DF E6
                XCH A,RO
+12E0 C8
                NEXT20002:
+12E1 C8
                XCH A,RO
                INC RO
+12E2 08
+12E3 26
                ADD A. @RO
+12E4 C8
                XCH A.RO
                CJNE A.TEMP_STORE.NEXT20002
+12E5 B51CF9
                XCH A.RO
+12E8 C8
                MOV PEEP_AVG, A
+12E9 F563
+12EB DOFO
                POP B
                 POP ACC
+12ED DOEO
                 POP PSW
+12EF DODO
                NOP
 12F1 00
                 NOP
 12F2 00
 12F3 00
                 NOP
                 AJMP CHK_WAIT
 12F4 6108
                 PAT_INSP:
 12F6 E563
                 MOV A.PEEP_AVG
 12F8 C3
                 CLR C
                 SUBB A.AWP_AVG : PEEP + AWP
 12F9 954C
                                  :AWP > PEEP
                 JC CHK_EDEXH
 12FB 40AA
                 SUBB A. #PATINSP_THRESH
 12FD 9408
                 JC CHK_EDEXH : ?NO PAT INSP
 12FF 40A6
                 CLR EXH
 1301 C201
                 SETB SPON_BR
 1303 D207
```

1305 00 1306 00 1307 00	NOP NOP NOP
1307 00	CHK_WAIT: :: CHECK 3 CYC WAIT
1308 30002E 1308 20042B 130E 200328 1311 200825 1314 7402 1316 C3 1317 952F 1319 501B 131B C200 131D C21E 131F D216 1321 D217 1323 852399 1326 D125 1328 7C00 132A 7D00 132C 755000 132F 755100 1332 6139 1334 00	JNB WAIT.GO_ON JB VEN_SEL,GO_ON JB VOL_CHG.GO_ON JB HOLD.GO_ON MOV A.#2 CLR C SUBB A.THREE_CYCLE JNC INC3 CLR WAIT CLR L16 SETB CLOG1 SETB CLOG2 MOV SBUF.LED1 ACALL TRANS_DEL MOV RON_TIM.#O :RESET AFTER WAIT MOV ROFF_TIM,#O MOV POSSUM,#O
1335 00	NOP
1336 052F 1338 00 1339 01D8 133B 00	INC3: INC THREE_CYCLE NOP GO_ON: ;:START MAIN LOOP AJMP MAIN_LOOP NOP
133C 61EB 133E 00	OUT1: AJMP OUT NOP
133F 1038FA 1342 D238 1344 200AF5 1347 C2D3 1349 C2D4 1348 100D50	BLINK_BEEP: ::ON/OFF DISPLAY & BUZZER JBC DIV23.OUT1 ; PERIOD 0.4S SETB DIV23 JB ALM_TST,OUT1 CLR PSW.3 ; BANKO CLR PSW.4 JBC OFF_ALM,TURN_OFF TURN_ON: -;:DISPLAY/ALM ON
134E D20D 1350 301F05 1353 852399 1356 D125	SETB OFF_ALM  JNB L17.CHK_LED21  MOV SBUF,LED1 ;RESTORE LED'S  ACALL TRANS_DEL  CHK_LED21:
1358 E526 135A 54F0 135C 6005 135E 852699 1361 D125	MOV A.LED2 ANL A.#OFOH JZ CHK_LED31 MOV SBUF.LED2 ACALL TRANS_DEL

	CHK_LED31:
1363 E525	MOV A.LED3
1365 54F0	ANL A.#OFOH
1367 6005	JZ CHK_VOL1
1369 852599	MOV SBUF.LED3 ACALL TRANS_DEL
1369 852599 136C D125	ACALL TRANS_DEL
136F 30030F	CHK VOL1: JNB VOL_CHG.TST_VENTSEL1
1371 852899	MOV SBUF. CHG_VOL : SET HUNS
1774 D125	ACALL TRANS DEL
1376 759901	MOV SBUF, #01H :SET TENS TO 0
1379 D125	ACALL TRANS_DEL
1377 0123	MOV SBUF. #02H :SET ONES TO 0
137E D125	ACALL TRANS_DEL
13/2 0123	TST_VENTSEL1:
1700 700404	
1380 300404 1383 8E99	MOV SBUF, RVENT
1385 D125	TST_TEMP1:
1387 303B0A	MOV SBUF, TEMP_DEC ; TENS
138A 851299	MUV SBUP, TEMP_DEC , TEMO
138D D125	ACALL TRANS_DEL
138F 759902	MOV SBUF, #02H ; ONES
1392 D125	ACALL TRANS_DEL
	TST_BEEP1:
1394 301454	JNB BEEP, OUT
1397 200651	JB SIL,OUT SETB P2.7 :BUZZER ON
	AJMP OUT
139C 61EB	TURN_OFF: ::DISPLAY/ALM OFF
139E 301F08	
	MOA H'FEDI
13A1 E523	AND A #7FH -MASK LFD'S
13A3 54/F	AND M. # /FII , INCOR DED O
13A3 54/F 13A5 F599	MOV SBUF, A
13A3 54/F	MOV SBUF, A ACALL TRANS_DEL
13A3 54/F 13A5 F599 13A7 D125	MOV SBUF,A ACALL TRANS_DEL CHK_LED22:
13A3 547F 13A5 F599 13A7 D125	MOV SBUF,A ACALL TRANS_DEL CHK_LED22: MOV A.LED2
13A3 547F 13A5 F599 13A7 D125 13A9 E526 13AB 54F0	MOV SBUF,A ACALL TRANS_DEL CHK_LED22: MOV A.LED2 ANL A,#0F0H
13A3 547F 13A5 F599 13A7 D125 13A9 E526 13AB 54F0 13AD 6005	MOV SBUF,A ACALL TRANS_DEL CHK_LED22: MOV A.LED2 ANL A,#0F0H JZ CHK_LED32
13A3 547F 13A5 F599 13A7 D125 13A9 E526 13AB 54F0 13AD 6005 13AF 759905	MOV SBUF,A ACALL TRANS_DEL CHK_LED22: MOV A.LED2 ANL A,#0F0H JZ CHK_LED32 MOV SBUF,#05H
13A3 547F 13A5 F599 13A7 D125 13A9 E526 13AB 54F0 13AD 6005	MOV SBUF,A ACALL TRANS_DEL CHK_LED22: MOV A.LED2 ANL A,#0F0H JZ CHK_LED32 MOV SBUF,#05H ACALL TRANS_DEL
13A3 547F 13A5 F599 13A7 D125 13A9 E526 13AB 54F0 13AD 6005 13AF 759905 13B2 D125	MOV SBUF,A ACALL TRANS_DEL CHK_LED22: MOV A.LED2 ANL A,#0F0H JZ CHK_LED32 MOV SBUF,#05H ACALL TRANS_DEL CHK_LED32:
13A3 547F 13A5 F599 13A7 D125 13A9 E526 13AB 54F0 13AD 6005 13AF 759905 13B2 D125	MOV SBUF,A ACALL TRANS_DEL CHK_LED22: MOV A.LED2 ANL A,#0F0H JZ CHK_LED32 MOV SBUF,#05H ACALL TRANS_DEL CHK_LED32: MOV A.LED3: MOV A.LED3
13A3 547F 13A5 F599 13A7 D125 13A9 E526 13AB 54F0 13AD 6005 13AF 759905 13B2 D125 13B4 E525 13B6 54F0	MOV SBUF,A ACALL TRANS_DEL CHK_LED22: MOV A.LED2 ANL A,#0F0H JZ CHK_LED32 MOV SBUF,#05H ACALL TRANS_DEL CHK_LED32: MOV A.LED3 ANL A.#0F0H
13A3 547F 13A5 F599 13A7 D125 13A9 E526 13AB 54F0 13AD 6005 13AF 759905 13B2 D125 13B4 E525 13B6 54F0	MOV SBUF,A ACALL TRANS_DEL CHK_LED22: MOV A.LED2 ANL A,#0F0H JZ CHK_LED32 MOV SBUF,#05H ACALL TRANS_DEL CHK_LED32: MOV A.LED3 ANL A.#0F0H JZ CHK_VOL2
13A3 547F 13A5 F599 13A7 D125 13A9 E526 13AB 54F0 13AD 6005 13AF 759905 13B2 D125 13B4 E525 13B6 54F0 13B8 6005 13BA 759906	MOV SBUF, A ACALL TRANS_DEL CHK_LED22: MOV A.LED2 ANL A, #0F0H JZ CHK_LED32 MOV SBUF, #05H ACALL TRANS_DEL CHK_LED32: MOV A.LED3 ANL A.#0F0H JZ CHK_VOL2 MOV SBUF, #06H
13A3 547F 13A5 F599 13A7 D125 13A9 E526 13AB 54F0 13AD 6005 13AF 759905 13B2 D125 13B4 E525 13B6 54F0 13B8 6005 13BA 759906 13BD D125	MOV SBUF,A ACALL TRANS_DEL CHK_LED22: MOV A.LED2 ANL A,#0F0H JZ CHK_LED32 MOV SBUF,#05H ACALL TRANS_DEL CHK_LED32: MOV A.LED3 ANL A.#0F0H JZ CHK_VOL2 MOV SBUF,#06H ACALL TRANS_DEL
13A3 547F 13A5 F599 13A7 D125 13A9 E526 13AB 54F0 13AD 6005 13AF 759905 13B2 D125 13B4 E525 13B6 54F0 13B8 6005 13BA 759906 13BD D125 13BF 30030F	MOV SBUF,A ACALL TRANS_DEL CHK_LED22: MOV A.LED2 ANL A,#OFOH JZ CHK_LED32 MOV SBUF,#O5H ACALL TRANS_DEL CHK_LED32: MOV A.LED3 ANL A.#OFOH JZ CHK_VOL2 MOV SBUF,#O6H ACALL TRANS_DEL CHK_VOL2 MOV SBUF,#O6H ACALL TRANS_DEL CHK VOL2: JNB VOL_CHG.TST_VENTSEL2
13A3 547F 13A5 F599 13A7 D125 13A9 E526 13AB 54F0 13AD 6005 13AF 759905 13B2 D125 13B4 E525 13B6 54F0 13B8 6005 13BA 759906 13BD D125 13BF 30030F 13C2 7599F0	MOV SBUF, A ACALL TRANS_DEL CHK_LED22: MOV A.LED2 ANL A, #OFOH JZ CHK_LED32 MOV SBUF, #O5H ACALL TRANS_DEL CHK_LED32: MOV A.LED3 ANL A.#OFOH JZ CHK_VOL2 MOV SBUF, #O6H ACALL TRANS_DEL CHK_VOL2: JNB VOL_CHG.TST_VENTSEL2 MOV SBUF.#OFOH ; OFF HUNS
13A3 547F 13A5 F599 13A7 D125 13A9 E526 13AB 54F0 13AD 6005 13AF 759905 13B2 D125 13B4 E525 13B6 54F0 13B8 6005 13BA 759906 13BD D125 13BF 30030F 13C2 7599F0 13C5 D125	MOV SBUF, A ACALL TRANS_DEL CHK_LED22: MOV A.LED2 ANL A, #0F0H JZ CHK_LED32 MOV SBUF, #05H ACALL TRANS_DEL CHK_LED32: MOV A.LED3 ANL A.#0F0H JZ CHK_VOL2 MOV SBUF, #06H ACALL TRANS_DEL CHK_VOL2: JNB VOL_CHG, TST_VENTSEL2 MOV SBUF, #0F0H ; OFF HUNS ACALL TRANS_DEL
13A3 547F 13A5 F599 13A7 D125 13A9 E526 13AB 54F0 13AD 6005 13AF 759905 13B2 D125 13B4 E525 13B6 54F0 13B8 6005 13BA 759906 13BD D125 13BF 30030F 13C2 7599F0 13C5 D125 13C7 7599F1	MOV SBUF, A ACALL TRANS_DEL CHK_LED22: MOV A.LED2 ANL A, #0F0H JZ CHK_LED32 MOV SBUF, #05H ACALL TRANS_DEL CHK_LED32: MOV A.LED3 ANL A.#0F0H JZ CHK_VOL2 MOV SBUF, #06H ACALL TRANS_DEL CHK_VOL2: JNB VOL_CHG, TST_VENTSEL2 MOV SBUF, #0F0H ; OFF HUNS ACALL TRANS_DEL MOV SBUF, #0F1H : OFF TENS
13A3 547F 13A5 F599 13A7 D125 13A9 E526 13AB 54F0 13AD 6005 13AF 759905 13B2 D125 13B4 E525 13B6 54F0 13B8 6005 13BA 759906 13BD D125 13BF 30030F 13C2 7599F0 13C5 D125 13C7 7599F1 13CA D125	MOV SBUF,A ACALL TRANS_DEL CHK_LED22: MOV A.LED2 ANL A,#OFOH JZ CHK_LED32 MOV SBUF,#O5H ACALL TRANS_DEL CHK_LED32: MOV A.LED3 ANL A.#OFOH JZ CHK_VOL2 MOV SBUF.#O6H ACALL TRANS_DEL CHK_VOL2: JNB VOL_CHG.TST_VENTSEL2 MOV SBUF.#OFOH ;OFF HUNS ACALL TRANS_DEL MOV SBUF.#OF1H :OFF TENS ACALL TRANS_DEL
13A3 547F 13A5 F599 13A7 D125 13A9 E526 13AB 54F0 13AD 6005 13AF 759905 13B2 D125 13B4 E525 13B6 54F0 13B8 6005 13BA 759906 13BD D125 13BF 30030F 13C2 7599F0 13C5 D125 13CA D125 13CA D125 13CC 7599F2	MOV SBUF,A ACALL TRANS_DEL CHK_LED22: MOV A.LED2 ANL A,#OFOH JZ CHK_LED32 MOV SBUF,#O5H ACALL TRANS_DEL CHK_LED32: MOV A.LED3 ANL A.#OFOH JZ CHK_VOL2 MOV SBUF.#O6H ACALL TRANS_DEL CHK_VOL2: JNB VOL_CHG.TST_VENTSEL2 MOV SBUF.#OFOH ;OFF HUNS ACALL TRANS_DEL MOV SBUF.#OF1H :OFF TENS ACALL TRANS_DEL MOV SBUF.#OF2H ;OFF ONES
13A3 547F 13A5 F599 13A7 D125 13A9 E526 13AB 54F0 13AD 6005 13AF 759905 13B2 D125 13B4 E525 13B6 54F0 13B8 6005 13BA 759906 13BD D125 13BF 30030F 13C2 7599F0 13C5 D125 13C7 7599F1 13CA D125	MOV SBUF.A ACALL TRANS_DEL CHK_LED22: MOV A.LED2 ANL A,#0F0H JZ CHK_LED32 MOV SBUF.#05H ACALL TRANS_DEL CHK_LED32: MOV A.LED3 ANL A.#0F0H JZ CHK_VOL2 MOV SBUF.#06H ACALL TRANS_DEL CHK_VOL2: JNB VOL_CHG.TST_VENTSEL2 MOV SBUF.#0F0H ; OFF HUNS ACALL TRANS_DEL MOV SBUF.#0F1H : OFF TENS ACALL TRANS_DEL MOV SBUF.#0F2H ; OFF ONES ACALL TRANS_DEL
13A3 547F 13A5 F599 13A7 D125 13A9 E526 13AB 54F0 13AD 6005 13AF 759905 13B2 D125 13B4 E525 13B6 54F0 13B8 6005 13BA 759906 13BD D125 13BF 30030F 13C2 7599F0 13C5 D125 13CA D125 13CA D125 13CC 7599F2	MOV SBUF,A ACALL TRANS_DEL CHK_LED22: MOV A.LED2 ANL A,#0F0H JZ CHK_LED32 MOV SBUF,#05H ACALL TRANS_DEL CHK_LED32: MOV A.LED3 ANL A.#0F0H JZ CHK_VOL2 MOV SBUF.#06H ACALL TRANS_DEL CHK_VOL2: JNB VOL_CHG.TST_VENTSEL2 MOV SBUF.#0F0H ;OFF HUNS ACALL TRANS_DEL MOV SBUF.#0F1H :OFF TENS ACALL TRANS_DEL MOV SBUF.#0F2H ;OFF ONES ACALL TRANS_DEL TST_VENTSEL2:

13D7 D125	MOV SBUF.#0F3H : VENT SEL OFF ACALL TRANS_DEL TST_TEMP2:
	JNB TEMP.TST_BEEP2  MOV SBUF.#OF1H :OFF TENS  ACALL TRANS_DEL
13F1 7599F2	MOV SBUF.#0F2H : OFF ONES ACALL TRANS_DEL
13E6 301402	TST_BEEP2: JNB BEEP.OUT CLR P2.7 :AUDIO OFF
	OUT.
13EB 758C70 13EE D2A9 13FO D28C 13F2 22	MOV THO.#70H :RST TIMERO SETB ETO SETB TRO RET
13F3 COEO 13F5 COFO	TIM_SAMP: ::TIMER O INTERRUPT PUSH ACC :SAVE SFR'S PUSH B
13F7 CODO	PUSH PSW
13F9 758C70	PUSH PSW MOV THO.#70H ;RESET TIMER SETB PSW.3 ;SELECT REGISTER BANK 1 CLR PSW.4 JBC DIV21,CLEAR SETB DIV21 ;FREQ 100HZ AJMP RETURN CLEAR: INC RCHG_TIM ;R1 DJNZ RDIV10,SAMPLE :R2 MDV RDIV10,#10 ;RESET RDIV10
13FE C2D4	CLR PSW.4
1400 100204 1403 D202	SETB DIV21 ; FREQ 100HZ
1405 A167	AJMP RETURN
1407 09 1408 DAZB	DJNZ RDIV10.SAMPLE :R2
140A 7A0A	MOV RDIV10,#10 ;RESET RDIV10
140C 100B04 140F D20B	MOV RDIVIO,#10 ;RESET RDIVIO JBC DIV22.SET_CLK SETB DIV22 AJMP SAMPLE
1411 8135	AJMP SAMPLE
	SET_CLK: ;:SET .25 CLOCK
1413 D239	SETB CLK
1415 100E02 1418 D20E	SETB DIV24
141A DB19	SET_CLR: ,.SET 120 SETB CLK  JBC DIV24,CONT6 SETB DIV24 CONT6: DJNZ RDIV5,SAMPLE ;R3 MOV RDIV5,#5 ;FREQ 1 HZ
1410 /605	
141E 300608	;SILENCE 2 MIN JNB SIL.CHK_HOLD
1421 C2A7	CIR DO 7 :BUZZER OFF
1423 DE04	DJNZ RSIL_TIM.CHK_HOLD : ?NOT 2 MIN MOV RSIL_TIM.#120 :R6. RESET 2 MIN
1425 7E78 1427 C206	CLR SIL
	CHK_HOLD: ::STOP NEB? JNB HOLD.SAMPLE
1429 300809 142C DF07	DJNZ RHOLD_TIM.SAMPLE :R7
1425 7F78	MOV RHOLD_TIM.#120
1430 200602 1433 D2A7	JB SIL.SAMPLE SETB P2.7 :ON BUZZER
1433 DZM/	

```
:: READ VENT SIG
                SAMPLE:
                CLR PSW.3
                           :BANK O
1435 C2D3
                CLR PSW.4
1437 C2D4
                                    :CLEAR MUX ADDRESS
                ANL P2.#11111000B
1439 53AOF8
                SETB P2.3
143C D2A3
                ANALOG RVENT_SIG
143E
                    :DELAY TIME FOR MUX
                NOP
+143E 00
                NOP
+143F 00
                NOP
+1440 00
                NOP
+1441 00
                NOP
+1442 00
                           :START CONVERSION
                CLR P2.3
+1443 C2A3
                    ;ALLOW CONV. TIME 5 MICROSEC
                NOP
+1445 00
                NOP
+1446 00
                NOP
+1447 00
                MOV RVENT_SIG, P1 ; SAVE DIGITAL OUTPUT
+1448 A990
                SETB P2.3
+144A D2A3
                NOP
 144C 00
                RUNNING_AVG VENT_LOW, 4. RVENT_SIG, VENT_AVG
 144D
                CALCULATES RUNNING AVERAGE OF 4 BYTES IN DATA MEMORY
                ; WITH A LOW ADDRESS OF LODATA. INPUT SIGNAL IS LOCATED
                :AT INSIG. AVERAGE OUTPUT IS AT AVG.
                PUSH PSW
+144D CODO
                PUSH ACC
+144F COEO
+1451 COFO
                PUSH B
                           :BANKO
                CLR PSW.3
+1453 C2D3
                CLR PSW.4
+1455 C2D4
                MOV A, #VENT_LOW :SET RO
+1457 7468
+1459 2404
                ADD A,#4
+145B 14
                DEC A
+145C F8
                MOV RO.A
                NEXT10004:
                DEC RO
+145D 18
                             :SHIFT UP
                MOV A, @RO
+145E E6
+145F 08
                INC RO
+1460 F6
                MOV @RO.A
+1461 18
                DEC RO
                CJNE RO. #VENT_LOW. NEXT10004 ; LODATA ADDRESS
+1462 B868F8
                MOV A.RVENT_SIG ; MOV NEW DATA TO VENT_LOW
+1465 E9
+1466 75F004
                MOV B.#4
+1469 84
                 DIV AB
                 MOV @RO.A
+146A F6
                MOV A. #VENT_LOW : ADD TO CALC VENT_AVG
+146B 746B
                 ADD A.#4
+146D 2404
+146F 14
                 DEC A
                 MOV TEMP_STORE,A
+1470 F51C
                 MOV A. @RO
+1472 E6
+1473 C8
                 XCH A,RO
                 NEXT20004:
                 XCH A.RO
+1474 C8
                 INC RO
+1475 08
                 ADD A. @RO
 -1476 26
                 XCH A.RO
 +1477 C8
                 CJNE A.TEMP_STORE.NEXT20004
 +1478 B51CF9
```

```
XCH A.RO
+147B C8
                MOV VENT_AVG.A
+147C F56C
                POP B
+147E DOF0
                 POP ACC
+1480 DOE0
                POP PSW
+1482 DOD0
 1484 00
                NOP
                 INC P2
 1485 05A0
                ANALOG RFLT_FLO
1487
                NOP :DELAY TIME FOR MUX
+1487 00
                NOP
+1488 00
+1489 00
                NOP
                NOP .
+148A 00
                 NOP
+1488 00
                             START CONVERSION
+148C C2A3
                 CLR P2.3
                        :ALLOW CONV. TIME 5 MICROSEC
                 NOP
+148E 00
                 NOP
+148F 00
                 NOP
+1490 00
                                     :SAVE DIGITAL DUTPUT
                MOV RFLT_FLO,P1
+1491 AA90
                 SETB P2.3
+1493 D2A3
                 NOP
 1495 00
                RUNNING_AVG FLTFLO_LO,4.RFLT_FLO.FLTFLO_AVG
                 :CALCULATES RUNNING AVERAGE OF 4 BYTES IN DATA MEMORY
 1496
                 :WITH A LOW ADDRESS OF LODATA. INPUT SIGNAL IS LOCATED
                 :AT INSIG. AVERAGE DUTPUT IS AT AVG.
                 PUSH PSW
+1496 CODO
                 PUSH ACC
+1498 COE0
                 PUSH B
+149A COF0
                            ; BANKO
                 CLR PSW.3
+149C C2D3
                 CLR PSW.4
+149E C2D4
                 MOV A.#FLTFLO_LO
                                    :SET RO
+14A0 7440
                 ADD A,#4
+14A2 2404
                 DEC A
+14A4 14
                 MOV RO, A
+14A5 FB
                 NEXT10006:
                 DEC RO
+14A6 18
                              ;SHIFT UP
                 MOV A. eRO
+14A7 E6
                 INC RO
+14AB 08
                 MOV @RO.A
+14A9 F6
                 DEC RO
+14AA 18
                 CJNE RO. #FLTFLO_LO.NEXT10006 ; LODATA ADDRESS
+14AB B840F8
                 MOV A.RFLT_FLO :MOV NEW DATA TO FLTFLO_LO
+14AE EA
                 MOV B.#4
+14AF 75F004
                 DIV AB
+1482 84
                 MOV @RO.A
+14B3 F6
                 MOV A #FLTFLO_LO ; ADD TO CALC FLTFLO_AVG
+1484 7440
                 ADD A.#4
+1486 2404
                 DEC A
+14B8 14
                 MOV TEMP_STORE.A
+1489 F51C
                 MOV A. @RO
+14BB E6
                 XCH A.RO
+14BC C8
                 NEXT20006:
                 XCH A.RO
+14BD CS
                 INC RO
+14BE 08
                 ADD A.@RO
+14BF 25
                 XCH A.RO
+14C0 C8
```

```
CJNE A.TEMP_STORE.NEXT20006
+14C1 B51CF9
+14C4 C8
                XCH A.RO
                MOV FLTFLO_AVG.A
+14C5 F544
                 POP B
+14C7 DOFO
                 POP ACC
+14C9 DOE0
                 POP PSW
+14CB DODO
                 NOP
 14CD 00
 14CE 05A0
                 INC P2
                 ANALOG RAW_PRESS
 1400
                     :DELAY TIME FOR MUX
                 NOP
+14D0 00
                 NOP
+14D1 00
                 NOP
+14D2 00
                 NOP
+14D3 00
                 NOP
+14D4 00
                 CLR P2.3 ;START CONVERSION
+14D5 C2A3
                 NOP :ALLOW CONV. TIME 5 MICROSEC
+14D7 00
                 NOP
+14D8 00
                 NOP
+14D9 00
                 MOV RAW_PRESS.P1 ;SAVE DIGITAL OUTPUT
+14DA AB90
                 SETB P2.3
+14DC D2A3
                 NOP
 14DE 00
                 RUNNING_AVG AWP_LD,4.RAW_PRESS,AWP_AVG
 14DF
                 ;CALCULATES RUNNING AVERAGE OF 4 BYTES IN DATA MEMORY :WITH A LOW ADDRESS OF LODATA. INPUT SIGNAL IS LOCATED
                 ;AT INSIG. AVERAGE OUTPUT IS AT AVG.
+14DF CODO
                 PUSH PSW
+14E1 COE0
                 PUSH ACC
+14E3 COF0
                 PUSH B
                 CLR PSW.3 ;BANKO
+14E5 C2D3
                 CLR PSW.4
+14E7 C2D4
                 MOV A, #AWP_LO :SET RO
+14E9 7448
+14EB 2404
                 ADD A.#4
+14ED 14
                 DEC A
                 MOV RO, A
+14EE F8
                 NEXT10008:
+14EF 18
                 DEC RO
                              :SHIFT UP
+14F0 E6
                 MOV A.@RO
+14F1 08
                 INC RO
                 MOV @RO,A
+14F2 F6
+14F3 18
                 DEC RO
                 CJNE RO, #AWP_LO.NEXT10008 ; LODATA ADDRESS
+14F4 B848F8
                                    :MOV NEW DATA TO AWP_LO
                 MOV A.RAW_PRESS
+14F7 EB
+14F8 75F004
                 MOV B.#4
                 DIV AB
+14FB 84
+14FC F6
                 MOV @RO, A -
                 MOV A. #AWP_LO :ADD TO CALC AWP_AVG
+14FD 7448
+14FF 2404
                 ADD A,#4
                 DEC A
+1501 14
                 MOV TEMP_STORE.A
+1502 F51C
                 MOV A. eRO
+1504 E6
                 XCH A.RO
+1505 C8
                 NEXT20008:
                 XCH A,RO
+1506 C8
                 INC RO
+1507 08
                 ADD A.@RO
 +1508 26
```

XCH A.RO

```
+1509 C8
                CJNE A.TEMP_STORE, NEXT20008
+150A B51CF9
                XCH A.RO
+150D C8
                MOV AWP_AVG.A
+150E F54C
                POP B
+1510 DOF0
                POP ACC
+1512 DOE0
                POP PSW
+1514 DODO
                NOP
 1516 00
                JNB INSP, NEXT_SAMP
 1517 30150A
                MOV A.AWP_MAX
 151A E54D
                CLR C
 151C C3
                SUBB A.AWP_AVG
 151D 954C
                JNC NEXT_SAMP
 151F 5003
                MOV AWP_MAX.AWP_AVG
 1521 854C4D
                NEXT_SAMP:
                NOP
 1524 00
                INC P2
 1525 05A0
                 ANALOG RNEB_FLO
 1527
                     :DELAY TIME FOR MUX
                NOP
+1527 00
                NOP
+1528 00
                NOP
+1529 00
                NOP
+152A 00
                 NOP
+152B 00
                             :START CONVERSION
                 CLR P2.3
+152C C2A3
                        ;ALLOW CONV. TIME 5 MICROSEC
                 NOP
+152E 00
                 NOP
+152F 00
                 NOP
+1530 00
                                     ;SAVE DIGITAL DUTPUT
                MOV RNEB_FLO,P1
+1531 AC90
                 SETB P2.3
+1533 D2A3
                 NOP
 1535 00
                 MOV A.RNEB_FLO :R4
 1536 EC
                 CLR C
 1537 C3
                 SUBB A,#50
 1538 9432
                 JC NEGFLO
 153A 400E
                 CLR C :DIV BY 4
 153C C3
                 RRC A
 153D 13
                 CLR C
 153E C3
                 RRC A
 153F 13
                 ADD A. POSSUM ; SUN POS FLOW
 1540 2550
                 MOV POSSUM, A ; SAVE
 1542 F550
                 JNC CONT1
 1544 500F
                 SETB FLOW ; OVERFLOW CONDITION
 1546 D20F
                 SJMP CONT1
 1548 800B
                 NEGFLO: :: NEG FLOW
                 MOV A.#50
 154A 7432
                 SUBB A.RNEB_FLO
 154C 9C
                        :DIV BY 4
                 CLR C
 154D C3
                 RRC A
 154E 13
                 CLR C
 154F C3
                 RRC A
 1550 13
                 ADD A, NEGSUM
 1551 2551
                 MOV NEGSUM.A ;SAVE
 1553 F551
                 CONT1:
                 NOP
 1555 00
                 INC P2
 1550 05A0
```

```
ANALOG RTEMP
1558
                     :DELAY TIME FOR MUX
                NOP
+1558 00
                NOP
+1559 00
                NOP
+155A 00
                NOP
+155B 00
                NOP
+155C 00
                             :START CONVERSION
                CLR P2.3
+155D C2A3
                      :ALLOW CONV. TIME 5 MICROSEC
                NOP
+155F 00
                NOP
+1560 00
                NOP
+1561 00
                                 :SAVE DIGITAL OUTPUT
                MOV RTEMP, P1
+1562 AD90
                SETB P2.3
+1564 D2A3
                NOP
 1566 00
                          :: RET FROM INT
                RETURN:
                POP PSW
 1567 DODO
 1569 DOF0
                POP B
                POP ACC
 156B DOE0
                RETI
 156D 32
                SERVICE: ;: CHK FLOW, SER-REC, BLINK
                JBC CLK, TEMP_CONT
 156E 103902
 1571 22
                RET
                NOP
 1572 00
                TEMP_CONT: ;: CONTROL HEATER
                 CLR PSW.3 ;BANKO
 1573 C2D3
                CLR PSW.4
 1575 C2D4
                MOV A.RTEMP ;R5
 1577 ED
                CJNE A, #TEMP_HI, NOT_EQ
 1578 B4A00C
                HITEMP: ;:OVER BOC
                          ;HEAT OFF
                 CLR PO.1
 157B C281
                 CLR HEAT
 157D C23A
                 SETB L35 ;HI TEMP LED
 157F D220
                 MOV SBUF, LED3
 1581 852599
                 SETB ALM
 1584 D20C
                 RET
 1586 22
                 NOT_EQ: JNC HI_TEMP ;RTEMP>TEMP_HI
 1587 5022
                 MOV A. TEMP_SET
 1589 E511
                 CJNE A,#40,HEAT_CHK
 158B B42804
                 CLR PO.1 ; HEAT OFF
 158E C281
                 AJMP FLO_TST
 1590 A1B5
                 HEAT_CHK: :: CHK HEAT BIT
                 JB HEAT, SW_OFF
 1592 203A0C
                 CLR C
 1595 C3
                 SUBB A,#10 ; LOW LIMIT
  1596 940A
                 SUBB A.RTEMP :R5
  1598 9D
                 JC FLO_TST ;?LEAVE OFF?
 1599 401A
                 SETB PO.1
                           TURN ON
  1598 D281
                 SETB HEAT
  159D D23A
                 AJMP FLO_TST
  159F A1B5
                 SW_OFF:
                 ADD A.#10 :UPPER LIMIT
  15A1 240A
                 CLR C
  15A3 C3
                 SUBB A.RTEMP
  15A4 9D
                 JNC FLO TST : ?LEAVE ON?
  15A5 500E
```

15A7 C281	CLR PO.1 :TURN OFF
0 0074	CLD HEAT
1344 0204	HI_TEMP: ;:TEMP ALARM
1540 0000	SETB L35 :HI TEMP LED
15AB 0220	MOV SRUE LED3
15AD 852577	ACALL TRANS DEL
15B0 D125	SCIP ALM
15B2 D20C	SETB L35 :HI TEMP LED  MOV SBUF, LED3  ACALL TRANS_DEL  SETB ALM  RET
15B4 22	FLO_TST: ;:TEST NEB FLOW
	FLU_ISI: ,. ICSI NES I DON
15B5 200070	JB WAII, CHK_SERPORI
1588 D2D3	SETB PSW.3 ;BANKI
158A C2D4	JB WAIT, CHK_SERPORT SETB PSW.3 ;BANK1 CLR PSW.4
	JBC FLOW, FLO
15BF E550	MOV A, POSSUM CLR C SUBB A, NEGSUM ; CALC SFLO
15C1 C3	CLR C
1502 9551	SUBB A.NEGSUM ; CALC SFLU
1504 5004	INL CURIZ
15C4 DD17	DJNZ ROFF_TIM.CONT4 AJMP NOFLO_ALM
15C8 A1F7	AJMP NOFLO_ALM
1500 EEEO	MOV B.A :SAVE SFLO=POS-NEG
150A F5F0	SURB A #NOFLO TH :SFLO-THRESH
1500 9480	THE CONTS
15CE 5004	NOTIO: DINZ ROFF TIM.CONT3
1500 DD02	ATMO NOTIO ALM
15D2 A1F7	ASMIT NOT LO _ALL
	CONT2: MOV B.A ;SAVE SFLO=POS+NEG SUBB A.#NOFLO_TH :SFLO-THRESH JNC CONT3 NOFLO: DJNZ ROFF_TIM,CONT3 AJMP NOFLO_ALM CONT3: MOV A.B ;SFLO CLR C SUBB A.#FLO_TH ;SFLO-THRESH JC CONT4 ;?SFLO <thresh djnz="" flo:="" ron_tim,cont4<="" td=""></thresh>
15D4 E5F0	MUV H,B ,31 L0
15D6 C3	CLR C
15D7 942D	SUBB A, #FLU_IR , SFLO (III.2011
15D9 4004	JC CON14 ; ?SPLOCIARES!
15DB DC02	FLO: DJNZ RON_TIM.CONT4 AJMP FLO_ALM
15DD C10E	AJMP FLO_ALM
	CONTA: **CHECK LINE
15DF 755000	MOV POSSUM, #0 ; RESET FLOW SUM
15E5 D51405	DJNZ ONTIMER.CHK_OFFTIM MOV ONTIMER.#FLOTIM
15E5 D51405 15E8 75140B	MOV ONTIMER.#FLOTIM
15EB 7COB	MOV RON_TIM, #FLOTIM
	OUR OFFTM.
15ED D51538	DJNZ OFFTIMER.CHK_SERPORT MOV OFFTIMER,#NOFLOTIM MOV ROFF_TIM,#NOFLOTIM
1550 751530	MOV OFFTIMER, #NOFLOTIM
15F0 751532 15F3 7D32	MOV ROFF_TIM, #NOFLOTIM
15F5 7D32 15F5 C128	AJMP CHK_SERPORT
1375 0128	Horn Starter
	NOFLO_ALM: :?NEB OFF > 105
	MOV POSSUM.#0
15F7 755000	MOV NEGSUM. #0
15FA 755100	MOV OFFTIMER. #NOFLOTIM
15FD 751532	MOV ROFF_TIM, #NOFLOTIM
1600 7D32	CETO DEED
1602 D214	SETB BEEP
1604 D20C	SETB ALM
1606 D234	SETB L24 :NO FLOW LED
1608 852699	MOV SBUF.LED2
160E D125	ACALL TRANS_DEL
160D 22	RET

```
;:NES IN : 2.25
                FLO_ALM:
                MOV POSSUM,#0
160E 755000
1611 755100
                MOV NEGSUM,#0
                MOV ONTIMER. #FLCTI
1614 751408
                MOV RON_TIM.#FLCT
1617 7COB
                SETB ALM ; FLAG
1619 D20C
                          ; CONT FLOW ALM
                SETB L27
161B D237
                MOV SBUF, LED2
161D 852699
                ACALL TRANS_DEL
1620 D125
                RET
1622 22
                BLINK_BEEP1: AJMS BLINK_BEES
1623 613F
                TRANS_DEL: ::DELAY 2.25MS.SC=ESE-
LJMP TRANS_DEL1
1625 0219BE
                CHK_SERPORT: ;:NEW CHAR RED?
                JNB RI, BLINK_BEEF:
1628 3098F8
                CLR RI
162B C298
                CLR ETO ; DISABLE TIMER O INT
CLR TRO ; DISABLE TIMEP O
162D C2A9
162F C28C
                             ;READ CODE RECEL EL
                MOV A.SBUF
1631 E599
                SWAP A
1633 C4
                RL A ; MULTIPLY 2 2
1634 23
                MOV DPTR, #JUMP_TBLE!
1635 901639
                JMP @A+DPTR
1638 73
                                           ; TEYF. 5ET
                JUMP_TBLE1: AJMP CASEO
1639 C17D
                                           :MEB. -ILI
                              AJMP CASEL
163B C1F4
                                           :SELF TEET
                              AJMP CASEZ
163D E19F
                                           :NO 407003
                              AJMP CASES
163F E19D
                                           :VENT BEL
                              AJMP CASE4
1641 E126
                                           :015FL4: TE:0
                              AJMP CASES
1643 E1A1
                              AJMP 048E61
                                           :4_* 51.
1645 C15D
                                           :80 4070
                              AJMP CASE71
1647 C161
                                           :2-4-35 .1.
                              AJMP CASES
 1649 E169
                                           :215=14. ***
                              AJMP CASER1
 164B C165
                                           :414 -555
                              AJMP CASEAL
 164D C169
                                           : 40 -071
                              AJMP CASEB1
 164F C16D
                                           : E4=E=
                              AJMP CASECI
 1651 C171
                                           :015=.4. =1=
                              AJMP CASED1
 1653 C175
                                           :414 7557
                              AJMP CASEE1
 1655 C179
                              AJMF 14SEF
 1657 C15A
 1659 00
                 NOP
                 CASEF: ; NO ACTIC>
                 AJMP BLINK_BEEP
 165A 613F
 165C 00
                 NOP
                 CASE61: LJMP CASES
 165D 02186D
 1660 00
                 NOP
                 CASE71: LJMP CASET
 1661 021867
 1664 00
                 NOP
                 CASE91: LJMP CASES
 1665 021818
 1668 00
                 NOP
 1669 02187A
                 CASEA1: LJMP CASE-
 156C 00
                 NOP
                 CASEB1: LJMP CASES
 166D 02186A
```

```
NOP
1670 00
                CASEC1: LJMP CASEC
1671 021843
                NOP
1674 00
                CASED1: LJMP CASED
1675 0218D7
                NOP
1678 00
                CASEE1: LJMP CASEE
1679 021955
                NOP
167C 00
                       ;:TEMP SET
                CASEO:
                JB TEMP, NEW_TEMP
167D 203B19
                SETB TEMP
1680 D23B
                MOV A. TEMP_SET
1682 E511
                CJNE A, #40, DISPLAY_TEMP
1684 B42820
                OFF_STATE: ::LCD "- -"
                MOV SBUF, #OFOH ; HUNS BLand
1687 7599F0
                ACALL TRANS_DEL
168A D125
                MOV SBUF, #OA1H ; TENS "-
168C 7599A1
                ACALL TRANS_DEL
168F D125
                MOV SBUF, #OA2H ; ONES "-
1691 7599A2
                ACALL TRANS_DEL
1694 D125
                AJMP BLINK_BEEP
1696 613F
                NOP
1698 00
                NEW_TEMP: ::NEXT SET TEXT
                MOV A, TEMP_SET
1699 E511
                CJNE A, #120, CALC_TEMP
169B B47805
                MOV TEMP_SET,#40
169E 751128
                AJMP OFF_STATE
16A1 C187
                CALC_TEMP:
                ADD A,#20
16A3 2414
                MOV TEMP_SET,A
16A5 F511
                DISPLAY_TEMP:
                CLR C
16A7 C3
                        ;DIV BY 2
                RRC A
16A8 13
                BINARY_BCD DEC_HUN,DEC_TE
16A9
                CONVERTS BYTE LOCATED
                                                   TE AND ONE.
                 ;AND STORES RESULT IN DEL_-
                                 ;CLEAR FEILETE
                MOV DEC_HUN,#0
MOV DEC_TEN,#0
MOV DEC_ONE,#0
+16A9 752900
+16AC 752A00
+16AF 752B00
                 CALC_HUNO011: ;:SUBTR-IT
                 MOV B,A
+16B2 F5F0
                 NEXTSUB10011:
                 CLR C-
+16B4 C3
                 SUBB A,#100
+16B5 9464
                 JC CALC_TENOO11
+16B7 4006
                 INC DEC_HUN
+1689 0529
                          ;SAVE
                 MOV B,A
+16BB F5F0
                 SJMP NEXTSUB10011
+16BD 80F5
                 CALC_TENO011: ;:SUBTR=:
                 MOV A.B
+16BF E5F0
                 NEXTSUB20011:
                 CLR C
+16C1 C3
                 SUBB A,#10
+1602 940A
```

```
JC CALC_DNEOO11
+1604 4006
                INC DEC TEN
+1606 052A
                MOV B,A
+1602 F5F0
                SJMP NEXTSUB20011
+15CA 80F5
                CALC_ONEOO11:
                MOV DEC_ONE.B
+1600 85F02B
                MOV A.DEC_HUN
+150F E529
                JNZ BCD_OUTOO11
+16D1 700A
               MOV DEC_HUN,#OFH
                                   :BLANK
+16D3 75290F
+1606 E52A
                MOV A, DEC_TEN
                JNZ BCD_OUTOO11
+16D8 7003
                                  :BLANK
                MOV DEC_TEN, #OFH
+16DA 752AOF
                BCD_OUTOO11:
                MOV SBUF, #OFOH ; HUN BLANK
 16DD 7599F0
 16E0 D125
                ACALL TRANS_DEL
                MOV A.DEC_TEN
 1652 E52A
 16E4 C4
                SWAP A
 16E5 4401
                ORL A.#OIH
                MOV TEMP_DEC, A ; SAVE TENS
 16E7 F512
 16E9 F599
                MOV SBUF.A
                ACALL TRANS_DEL
 16EB D125
 16ED 759902
                MOV SBUF, #02H ; ONES
                ACALL TRANS_DEL
 16F0 D125
                AJMP BLINK_BEEP
 16F2 613F
                         ::NEBULIZER HOLD
                CASE1:
 16F4 D2D3
                SETB PSW.3 :BANK1
                CLR PSW.4
 16F6 C2D4
                JBC HOLD, HOLD_OFF
 16F3 100810
                SETB HOLD
                           ;HOLD FLAG
 16FB D208
                SETB BEEP
 16FD D214
                SETB L25
                             :NEB HOLD LED
 16FF D235
                MOV SBUF, LED2
 1701 852699
                ACALL TRANS_DEL
 1704 D125
                ORL P2, #01110000B ; OFF VALVES
 1706 43A070
 1709 800B
                SJMP HOLD_OUT
                HOLD_OFF:
                            ;HOLD FLAG
                CLR HOLD
 170B C20B
                CLR BEEP
 170D C214
                            :OFF HOLD LED
 170F C235
                CLR L25
 1711 852699
                MOV SBUF, LED2
 1714 D125
                ACALL TRANS_DEL
                HOLD_OUT:
                MOV RHOLD_TIM.#120 ;R7 RESET
 1716 7F78
                SETB WAIT
 1718 D200
                SETB L16 ; WAIT LED
 171A D21E
 1710 852399
                MOV SBUF.LED1
                ACALL TRANS_DEL
 171F D125
 1721 752F00
                MOV THREE_CYCLE.#0
 1724 613F
                AJMP BLINK_BEEP
                         ::SELECT VENT
                 CASE4:
                ORL P2.#01110000B : VALVES OFF
 1705 43A070
 1729 D204
                SETB VEN_SEL
 1728 D200
                SETB WAIT
```

```
MOV THREE_CYCLE.#0
172D 752F00
               SETB L16 :WAIT
1730 D21E
               MOV SBUF.LED1
1732 852399
               ACALL TRANS_DEL
1735 D125
               CLR PSW.3
1737 C2D3
               CLR PSW.4
1739 C2D4
                             :R4, INC. VENT. NO.
               MOV A.RVENT
173B EE
               ADD A,#10H
173C 2410
               CJNE A, #43H, SEE_VENT
173E B44302
               MOV A,#13H ;RESET #1
1741 7413
               SEE_VENT:
MOV RVENT, A
1743 FE
                                  ;DISPLAY NEW NUMBER
               MOV SBUF, RVENT
1744 8E99
               ACALL TRANS_DEL
1746 D125
                             ;LOOK UP THRESHOLDS FOR VENTILATOR SELECTED
               NOP
1748 00
               MOV A, RVENT
1749 EE
               SWAP A
174A C4
               ANL A, #OFH ; CLEAR ADDRESS
RL A ; MULT. BY 2
174B 540F
174D 23
               MOV B.A ; SAVE
174E F5F0
               ACALL VENT_TBLE
1750 F15D
                                STORE UPPER THRESH
                MOV VENT_HI,A
1752 F51B
                MOV A,B
1754 E5F0
                DEC A
1756 14
                ACALL VENT_TBLE
1757 F15D
                                ;STORE LOWER THRESH
                MOV VENT_LO,A
1759 F51A
                AJMP BLINK_BEEP
175B 613F
                VENT_TBLE: MOVC A, @A+PC
175D 83
                RET ; THRESHOLDS
                DB 3BH,45H,81H,86H,3BH,45H; SERVO LO 2.3V, HI 2.7V
175E 22
175F 3B 45 81
                ;PB7200 LO 5.05V, HI 5.25V, HAM LO 2.3V, HI 2.7V
1762 86 3B 45
                CASE81: :: INITIALIZATION ENTRY
                CLR ETO
1765 C2A9
                CLR TRO
1767 C28C
                CASEB: ;:CHANGE VOLUME
SETB VOL_CHG
1769 D203
                MOV A, CHG_VOL
176B E528
                SWAP A
176D C4
176E 23
                RL A
                MOV B.A
176F F5F0
                ACALL CHGVOL_TBLE
1771 F18F
                MOV SET_CHGTIM.A
 1773 F519
                MOV A.B
 1775 E5F0
                DEC A
 1777 14
                ACALL CHGVOL_TBLE
 1778 F18F
                MOV CHG_VOL.A
 177A F528
                MOV SBUF, CHG_VOL
 1770 852899
                 ACALL TRANS_DEL
 177F D125
                 SETB WAIT
 1781 D200
                 MOV THREE CYCLE. #0
 1783 752F00
                 SETB L16
 1786 D21E
```

```
MOV SBUF. LED1
1788 852399
               ACALL TRANS_DEL
1788 D125
               AJMP BLINK_BEEP
178D 613F
               CHGVOL_TBLE: :: SELECT NEW VOL
                MOVC A.@A+PC
178F 83
               RET
1790 22
1791 20 14 40 DB 20H,20,40H,40.0,0,60H,60,0.0.10H,10
1794 28 00 00 60 3C 00 00 10 0A
                    :SHIFT TO NEW VOLUME
                        ;:NO ACTION
                CASE3:
                AJMP BLINK_BEEP
179D 613F
                CASE2: ; NO ACTION
                AJMP BLINK_BEEP
179F 613F
                CASES: ;:DISPLAY TEMP
                JBC SEE_TEMP, RESTORE_VOL1
17A1 10105B
                SETB SEE_TEMP
17A4 D210
17A6 C2D3
                CLR PSW.3 ;BANKO
17A8 C2D4
                CLR PSW.4
                MOV A.RTEMP :R5
17AA ED
                CLR C
17AB C3
                      ;DIV BY 2
                RRC A
17AC 13
                BINARY_BCD DEC_HUN, DEC_TEN, DEC_ONE
17AD
                ; CONVERTS BYTE LOCATED IN ACC TO DECIMAL
                :AND STORES RESULT IN DEC_HUN, DEC_TEN AND ONE.
                MOV DEC_HUN,#0 ;CLEAR REGISTERS
+17AD 752900
                MOV DEC_TEN,#0
+17B0 752A00
                MOV DEC_ONE,#0
+17B3 752B00
                CALC_HUN0012: ::SUBTRACT 100
+17B6 F5F0
                MOV B,A
                NEXTSUB10012:
+17B8 C3
                CLR C
+1789 9464
                SUBB A,#100
                JC CALC_TENO012
+17BB 4006
+17BD 0529
                INC DEC_HUN
+17BF F5F0
                           :SAVE
                MOV B,A
                SJMP NEXTSUB10012
+17C1 80F5
                CALC_TENO012: ;:SUBTRACT 10
+17C3 E5F0
                MOV A,B
                NEXTSUB20012:
                CLR C
+17C5 C3
+17C6 940A
                SUBB A. #10-
                JC CALC_ONEO012
+17C8 4006
                INC DEC_TEN
+17CA 052A
+17CC F5F0
                MOV B.A
                SJMP NEXTSUB20012
+17CE 80F5
                CALC_ONEO012:
                MOV DEC_ONE,B
+17D0 25F02B
                MOV A.DEC_HUN
+17D3 E529
                JNZ BCD_OUTOO12
+17D5 700A
+17D7 75290F
                MOV DEC_HUN, #OFH : BLANK
                MOV A.DEC_TEN
+17DA E52A
```

```
JNZ BCD_OUTOO12
MOV DEC_TEN.#OFH
+17DC 7003
                                    :BLANK
+17DE 752AOF
                 BCD_OUTO012:
                 NOP
 17E1 00
                 MOV A.DEC_HUN
 17E2 E529
                 SWAP A
 17E4 C4
                 MOV SBUF.A
 17E5 F599
                 ACALL TRANS_DEL
 17E7 D125
                 MOV A, DEC_TEN
 17E9 E52A
                 SWAP A
 17EB C4
 17EC 4401
                 ORL A.#01H
                 MOV SBUF.A
 17EE F599
                 ACALL TRANS_DEL
 17FO D125
                 MOV A, DEC_ONE
 17F2 E52B
                 SWAP A
 17F4 C4
                 ORL A,#02H
 17F5 4402
                 MOV SBUF, A
 17F7 F599
                 LCALL TRANS_DEL
 17F9 121625
                 LJMP BLINK_BEEP
 17FC 02133F
                 RESTORE_VOL1: ;:DISPLAY VOL
                 CLR PSW.3 ;BANK2
 17FF C2D3
                 SETB PSW.4
 1801 D2D4
                 MOV SBUF, CHG_VOL
 1803 852899
                 LCALL TRANS_DEL
 1806 121625
                 MOV SBUF,#01H
 1809 759901
                 LCALL TRANS_DEL
 180C 121625
                 MOV SBUF, #02H
 180F 759902
                 LCALL TRANS_DEL
 1812 121625
                 OUT_TEMP:
                 LJMP BLINK_BEEP
 1815 02133F
                 CASE9: ;:DISPLAY FLT LOAD
                 JBC SEE_LD, RESTORE_VOL2
 1818 101113
                 SETB SEE_LD
 181B D211
                 MOV SBUF, FLTLD_HUN
 181D 852C99
                 LCALL TRANS_DEL
 1820 121625
                 MOV SBUF, FLTLD_TEN
 1823 852D99
                 LCALL TRANS_DEL
 1826 121625
                 MOV SBUF, FLTLD_ONE
 1829 852599
                 AJMP OUT_DISPLD
 182C 0140
                 RESTORE_VOL2: ::DISPLAY VOL
                 MOV SBUF.CHG_VOL
 182E 852899
                 LCALL TRANS_DEL
 1831 121625
                 MOV SBUF, #01H
 1834 759901
                 LCALL TRANS_DEL
 1837 121625
                 MOV SBUF, #02H
 183A 759902
                 LCALL TRANS_DEL
 183D 121625
                 OUT_DISPLD:
                 LJMP BLINK_BEEP
 1840 02133F
                           :: ENTER KEY
                  CASEC:
                  CLR VEN_SEL
 1843 C204
                  CLR VOL_CHG
 1845 C203
                  CLR TEMP
 1847 C23B
```

1848 C2D4 184D 8E99 184F 121625 1852 852899 1855 121625 1858 759901 185B 121625 185E 759902 1861 121625	CLR PSW.3 :BANKO CLR PSW.4 MOV SBUF,RVENT LCALL TRANS_DEL MOV SBUF,CHG_VOL ;SET HUNS LCALL TRANS_DEL MOV SBUF,#01H ;SET TENS LCALL TRANS_DEL MOV SBUF,#02H ;SET ONES LCALL TRANS_DEL LJMP BLINK_BEEP
1867 02133F	CASE7: ;:NO ACTION LJMP BLINK_BEEP
186A 02133F	CASEB: ;:NO ACTION LJMP BLINK_BEEP
186F C2D4 1871 C2A7 1873 D206 1875 7E78	CASE6: ;:SIL ALM 2 MIN SETB PSW.3 ;BANK1 CLR PSW.4 CLR P2.7 ;OFF BUZZER SETB SIL ;SILENCE FLAG MOV RSIL_TIM,#120 ;R6,TWC TIME LJMP BLINK_BEEP
1880 752100 1883 752200 1886 752700 1889 D200 1888 D21E 188D C21D 188F C21F 1891 852399 1894 31BE 1896 852899 1899 31BE	CASEA: ;:ALM RST MOV P2.#78H ;OUTPUTS OFF MOV 20H,#0 ;CLEAR BITS MOV 21H,#0 MOV 22H,#0 MOV 27H.#0 SETB WAIT SETB L16 ;WAIT CLR L15 ;FILT CHANGE CLR L17 ;LOFLOW MOV SBUF,LED1 ACALL TRANS_DEL1 MOV SBUF,CHG_VOL ;NORMAL LCC ACALL TRANS_DEL1 MOV SBUF,#01H ACALL TRANS_DEL1 MOV SBUF,#02H ACALL TRANS_DEL1 CLR PSW.3 ;BANKO CLR PSW.4 MOV SBUF,RVENT ;R1 ACALL TRANS_DEL1 ANL LED2,#0FH ;OFF MOV SBUF,LED2 ACALL TRANS_DEL1 CLR L34 ;HI PRESS MOV SBUF,LED3 ACALL TRANS_DEL1 MOV THREE_CYCLE,#0 ;RESET

:BANK1

SETB PSW.3

```
188F 1213
               CLR PSW.4
18C1 020-
               MOV RON_TIM,#0
1803 7000
18C5 7
               MOV ROFF_TIM, #0
               MOV POSSUM.#0
18C7 755:00
               MOV NEGSUM,#0
18CA -55100
                              :RST TIMER
18CD 755070
               MOV THO, #70H
                              :SET ETO
               MOV IE,#87H
18D0 75-357
               MOV TCON. #50H ;SET TRO
18D3 755550
18D6 22
               RET
                         ::DISPLAY PIP
               CASED:
                  MULTIPLY BY SCALE FACTOR OF 5/8, CONVERT TO BCD
                  ; AND DISPLAY PIP. RETURN TO VOLUME DISPLAY WHEN
                  SWITCH IS PRESSED A SECOND TIME.
               JBC SEE_PIP, LCD_VOL
18D7 100763
               SETB SEE_PIP
18DA 0209
               MOV A, PIP_STORE
18DC E54E
               MOV B,#5
18DE 75F005
                         :MSB IN B
               MUL AB
18E1 A4
                         ;RRC 3 TIMES TO DIVIDE BY 8
               XCH A,B
18E2 C5=3
                          :MSB IN A
               RRC A
18E4 13
                         :LSB IN A
18E5 C5F3
               XCH A.B
               RRC A
18E7 13
                         SECOND ROTATION
               CLR C
18E8 C3
               XCH A.B
18E9 C5FC
               RRC A
18EB 13
18EC C3=3
               XCH A.B
               RRC A
18EE 13
                         THIRD ROTATION
                CLR C
18EF CZ
               XCH A,B
18F0 C5F0
                RRC A
18F2 13
                XCH A,B
18F3 CEFC
                RRC A
18F5 13
                SUBB A.#14H ;ZERO OFFSET
18F6 941-
                BINARY_BCD DEC_HUN, DEC_TEN, DEC_ONE
                CONVERTS BYTE LOCATED IN ACC TO DECIMAL
18F8
                AND STORES RESULT IN DEC_HUN, DEC_TEN AND ONE.
                                ;CLEAR REGISTERS
                MOV DEC_HUN,#0
+18F8 751900
                MOV DEC_TEN,#0
+18FB 752400
                MOV DEC_ONE,#0
+18FE TEIECO
                CALC_HUN0013: ::SUBTRACT 100
                MOV B.A
+1901 ===:
                NEXTSUB10013:
                CLR C
+1903 33
                SUBB A.#100
+1904 ====
                JC CALC_TENO013
+1906 400=
                INC DEC_HUN
+1908.2529
                           :SAVE
+190A FEFT
                MOV B.A
                SJMP NEXTSUB10013
+190C 30F5
                CALC_TENO013: ::SUBTRACT 10
                MOV A.B
+190E EEF!
                NEXTSUB20013:
                CLR C
+1910 II
```

```
SUBB A.#10
+1911 940A
                 JC CALC_ONEO013
+1913 4006
                 INC DEC_TEN
+1915 052A
                 MOV B.A
+1917 F5F0
                 SJMP NEXTSUB20013
+1919 80F5
                 CALC_ONEO013:
                 MOV DEC_ONE.B
+191B 85F02B
                 MOV A, DEC_HUN
+191E E529
                 JNZ BCD_OUTOO13
+1920 700A
                 MOV DEC_HUN, #OFH
                                     :BLANK
+1922 75290F
                 MOV A, DEC_TEN
+1925 E52A
                 JNZ BCD_OUTOO13
MOV DEC_TEN,#OFH
+1927 7003
                                     :BLANK
+1929 752AOF
                 BCD_OUTO013:
                 MOV A, DEC_HUN ; DISPLAY PIP
 192C E529
                 SWAP A
 192E C4
                 MOV SBUF, A
 192F F599
                 ACALL TRANS_DEL1
 1931 31BE
                 MOV A.DEC_TEN
 1933 E52A
                 SWAP A
 1935 C4
                 ORL A.#O1H
 1936 4401
                 MOV SBUF.A
 1938 F599
                 ACALL TRANS_DEL1
 193A 31BE
                 MOV A.DEC_ONE
 193C E52B
                 SWAP A
 193E C4
                 ORL A,#02H
 193F 4402
                 MOV SBUF, A
 1941 F599
                 SJMP OUTPIP
 1943 800D
                 LCD_VOL: ::DISPLAY VOL
                 MOV SBUF, CHG_VOL
 1945 852899
                 ACALL TRANS_DEL1
 1948 31BE
                 MOV SBUF,#01H
 194A 759901
                 ACALL TRANS_DEL1
 194D 31BE
                 MOV SBUF, #02H
 194F 759902
                 OUTPIP:
                 LJMP BLINK_BEEP
 1952 02133F
                           ; :ALM TEST
                 CASEE:
                  : PUSH SW TO TEST & PUSH TO RETURN
                  JBC ALM_TST.NORMAL
 1955 100A33
                  SETB ALM_TST
 1958 D20A
                              ON BUZZER
                  SETB P2.7
 195A D2A7
                  MOV A,#80H
 195C 7480
                               HUNS LCD TEST
                  MOV SBUF, A
 195E F599
                  LCALL _TRANS_DEL1
 1960 1219BE
                               ; TENS
                  INC A
 1963 04
                  MOV SBUF, A
 1964 F599
                  LCALL TRANS_DEL1
 1966 1219BE
                               :ONES
 1969 04
                  INC A
                  MOV SBUF, A
 196A F599
                  LCALL TRANS_DEL1
 196C 1219BE
                               :VENT #
 196F 04
                  INC A
                  MOV SBUF.A
 1970 F599
                  LCALL TRANS DEL1
 1972 1219BE
                  MOV A. #OF4H : LED1 TEST
 1975 74F4
```

```
~OV SBUF,A
1977 F599
               _CALL TRANS_DEL1
1979 1219BE
                           ;LED2
               INC A
197C 04
               MOV SBUF.A
197D F599
               _CALL TRANS_DEL1
197F 1219BE
               INC A
1982 04
                            ;LED3
               MOV SBUF, A
1983 F599
               _CALL TRANS_DEL1
1985 1219BE
               '_JMP OUT_TST
1988 0219BA
               HORMAL: ;:NORMAL DISPLAY
               CLR P2.7 : RESTORE ALARM & DISPLAYS
198B C2A7
                          :BANKO
               CLR PSW.3
198D C2D3
               CLR PSW.4
198F C2D4
               MOV SBUF, CHG_VOL
1991 852899
               LCALL TRANS_DEL1
1994 1219BE
               MOV SBUF, #01H
1997 759901
               LCALL TRANS_DEL1
199A 1219BE
               MOV SBUF, #02H
199D 759902
               LCALL TRANS_DEL1
19A0 1219BE
               MOV SBUF, RVENT
19A3 BE99
               LCALL TRANS_DEL1
19A5 1219BE
               MOV SBUF, LED1
19A8 852399
                _CALL TRANS_DEL1
19AB 1219BE
               MOV SBUF, LED2
19AE 852699
                LCALL TRANS_DEL1
19B1 1219BE
                MOV SBUF.LED3
1984 852599
                LCALL TRANS_DEL1
19B7 1219BE
                OUT_TST:
                LJMP BLINK_BEEP
198A 02133F
                NOP
19BD 00
                TRANS_DEL1: ;:DELAY 2.25MS,CC=80EH
                DJNZ DIVIDE1.TRANS_DEL1 ;COUNT 255
19BE D51DFD
                MOV DIVIDE1, #OFFH : RESET
19C1 751DFF
                                          ;COUNT 4
                DJNZ DIVIDE2.TRANS_DEL1
19C4 D51EF7
                MOV DIVIDE2,#04H ;RESET
19C7 751E04
                RET
19CA 22
                NOP
19CB 00
                         ;:ON VALVES
                MAN_SW:
                PUSH ACC
19CC COEO
                PUSH PSW
19CE CODO
                         :DISABLE INT
                CLR EXO
19D0 C2A8
                ANL P2,#10001111B ; ON VALVES
19D2 53A08F
                HOLDIT: LCALL SERVICE
19D5 12156E
                JNB P3.2, HOLDIT
19D8 30B2FA
                SETB WAIT
19DB D200
                           ; WAIT LED
                SETB L16
19DD D21E
                MOV SBUF.LED1
19DF 852399
                ACALL TRANS_DEL1
19E2 31BE
                                   ;OFF VALVES
                CRL P2.#01110000B
19E4 43A070
                MOV THREE_CYCLE.#OOH
19E7 752F00
                          :ENABLE INTO
                SETB EXO
19E4 D2A8
                FOP PSW
 19EC DODG
                POP ACC
 19EE DOEC
```

WO 92/12750

-47-

PCT/US92/00566

19FO 32

RETI

19F1

;%E ENDS :CODE SEGMENT

END BEGIN 1000

;%T	Sy	mba	ol	N	am	e						Т	уp	e	Value
A. ADM								-	_					L	112F
ALARM	•	•	-	•	•	:	-		_	_				L	11AB
ALARM1			-	•	•	•	•		•	-	_	_		L	12A4
ALARM2		•	-	•										В	0000
ALM . ALM_TS	•	:	-	•	•	•	•	-	•	-	•	•	•	_	000A
ALM_TS	:T	_	_	_	-		•	•	-	•	•	•	•	M	0000
ANALOG	ì .		-	-	-	-	-	•	•	•	•	•	•		004C
ANALOG	G'		•	-	-	•	•	•	•	-	•	-	•	D	
AWP LC	).			-	•	-	-	•	•	-	-	•	•	D	0048
ALID MA	v				_	_	_	-	-	-	•	-	-	D	004D
BANKO BCD_OL					•		-	-	•	-	-	•	•	U	0000
BCD OL	JΤO	01	1			-	-			-	-	-	•	L	16DD
BCD_OL	ITO	01	2	_			_			-	-	•	•	L	17E1
BCD_OL	iΤO	01	_ 3			_	_				-	-	•	Ŀ	192C
BEEP.	, , ,	-	_	•	-	_	_				_	-		В	0014
BEEP.	•	-	•	•	•	•	-	-		_				L	1000
BEGIN BINARY	<i>,</i>	<u>.</u>	•	•	•	•	•	•	-	_	_	_			0000
BLINK,	_5	CD	-	•	•	•	•	-	•	•	_	_		L	133F
BLINK_	BE	EP	-	-	•	•	-	•	•	•	•	•		_	1623
BLINK	_BE	EP	1	-	•	•	•	•	•	•	•	•			16B2
CALC_F	IUN	00	11	•	•	-	-	-	•	-	-	•			17B6
CALC_H	IUN	00	12	•	•	÷	-	-	•	-	-	•			1901
CALC_F	HUN	100	13	-	•	•	-	•	-	-	•	•	•		16CC
CALC (	)NE	:00	11		•	-	-	•	•	-	-	-	-	Ļ	
CALC	<b>つい E</b>	00	12		_	_	_	-			-	•	-		17D0
CALC_C	ON E	00	13		-		-	-	•	-	-	-	-	L	191B
CALC	PIF	3_						-		-	-	-	-		115D
CALC_	ΓEM	1P	_				_			-	•	•	•		16A3
COLC_1	ren	100	1 1	_	_	_	-	-	_	-	•	•	•	L	16BF
0010	FEN	-	17				_	_	_	-		•		L	17C3
CALC_		100	13	•			_							L	190E
CHLC_	, <u>–</u> ,		10	•	•	•	_	_	_					L	167D
CASE1	•	•	-	•	•	•	-	-	_	_				L	16F4
CASEI	•	•	•	•	•	•	•	•		_	-	_		L	179F
CASE2	•	•	•	-	•	•	•	•	•	•	-	_	_	L	179D
CASE3	•	•	-	-	-	•	•	•	•	•	•	_	-	L	1726
CASE4	•	•	•	-	-	•	•	-	•	•	•	•	•		17A1
CASE5	-	-	-	-	•	•	•	-	-	•	•	•			186D
CASE6	-	-	•	•	-	•	-	-	•	-	-	•			165D
CASE6	1.	•	•	-	•	-	-	-	•	-	•	•	•	_	1867
CASE7	•	-	•	•	•	•	-	•	•	-	•	-	•	, <u>-</u>	1661
CASE7	1.	•	-	-	•	•	•	-	•	•	•	-	•	L	1769
CASE8	•	•	-	-	-	•	•	•	•	-	•	•	•	L	1765
CASES	1.	-	-	-	-	-	•	-	•	-	-	•	•		1818
CASE9	•		-	-	-	-	-	•=	<b>-</b>	• .	. •	-	•	L	1665
CASE9	l.		-	-	•	•	•	-	•	-	-	-	•	L	
CASEA		-	-		-			-	-	-	-	•	•	L	187A
CASEA	1.	_		_			-		•	-	•	-	•	L	1669
CASEB	_	_	_			-		-		-	•	•	•	Ŀ	186A
CASEB	1		_	_	-	-		-		-	-	•	•	L	166D
CASEC		•		•		_	_							L	1843
CASEC	1	•	•	•	-	-	-	_	_					L	1671
		•	•	•	•	•	•	-	-	_	_			L	18D7
CASED		•	•	-	•	•		•	•	•	-	_		L	1675
CASED	1 -	•	•	•	-	•	•	•	•	•	-	-	_	L	1955
CASEE	-	-	-	•	-	•	-	-	•	•	•	•	-	_	

CASI	== 1											_	_	_	L	1679
			•	•		•	•	•	•	•	•				L	165A
CASI			•	-	•	•	•	•	•	•	-	•	•	•	Ĺ	1184
CHA	RGE	•	<u>.</u>	•	•	•	-	•	•	•	•	•		•		178F
CHG'	VOL	_T	BL	Ε	-	•	•	•	•	•	•	•		•	L	
CHG	_vo	L				•	-	•	-	•	•	•	•	•	D	0028
CHK.	_	E)												-	L	1107
CHK	CH	GT	TM	_	_	_			_	_					L	11E6
CHK		TH	<u> </u>	SH	-	•	-			•	_			_	L	1242
						•	•			•	•	:	•			12A7
CHK	_50	EX	п.	•	•	•	•	•	•	•	•	•	•	•	L	123F
CHK	_EO	EX	Ηı	•	•	•	•	•	•	•	•	•	•	•		
CHK.	_EX	Ή	-	•	•	•	•	•	•	•	•	•	•	•		1100
CHK.	HO	LD									-			-	L	1429
CHK												-			L	1358
CHK					-							_			L	13A9
CHI.		.02	-	•	•	•	•	•	•	:		•	-	_	Ē	1363
CHK		.03	_	•	•	•	•	•	•	•	•	•	•	•	L	13B4
CHK					•	•	•	-	•	•	•	•	•	-	_	
CHK	_OF	FT	IM		•	-	-	•	•	•	-	•	•	-		15ED
CHK	PE	AK				-	-		•		-	-		•	L	1150
СНК						_					-			-	L	162B
CUK	C T				_	_	_	-			-		_	_	L	1134
CHK	_31		•	•		• .	•	•	•	•	•	•	-	•	Ī	1106
CHK				•	-	-	•	-	•	•	٠	•	•	•		136E
CHK	_					•		•	•	•	•	•	•	•	L	
CHK	_V0	)∟2					-	•	-	•	•	•	-	-	L	138F
CHK	WA	TIF	•										-	-	L	1308
CHK	_we	ATT	1	_											L	11E3
CLE											_	_		_	L	1407
-			•	•	•			•	•	•	:	:	•	•	В	0039
CLK			•	•	-	_							٠	•	В	0016
CLO	GI	-	•			•	•	•	-	•	•	•	•	-	_	
CLO	G2		•	-	•	-	-	•	-	•	•	•	-	•	₿	0017
CLO	G_	ΗI	-			-	-	-	-		•		-	•	D	0046
CLO	G L	_0					_	-					•		D	0045
CON			_						-						L	113C
CON				-	-	-					_	_	_		L	1555
CON	70	•		•	•	•	•	:	:	•	•	•	-		Ĺ	15CA
			-	•	•	•	•				•	٠	•	•	L	15D4
CON			•	•	-	-	•	•	•	•	•	•		•		
CON			-	•	-	-	•	•	•	-	•	•	-	-	L	15DF
CON	T5			-	-	-	-	-	-		-	•	-	-	L	10D2
CON			_										-	-	L	141A
DEC				-		_	_								D	0029
DEC			•	•		•					-		_	_	D	002B
			•						•			Ċ	•	•	Ď	002A
DEC			•	•	•	•	•				•	•	•	•	B	0012
DEL			•	•	•	•	-	•	•	•	•	•	•	•		
DEL	AY.	1.	•	-	•		-	•	-	•		-	•	•	L	1006
DEL	AY:	2.						-	-				-	-	L	10CB
DEL			_		_	_	_								L	1122
DEL			JŤL	<u>.</u>	٠	-	٠	-	_	_					В	0013
					٠.	•	•	•	•	•	•	•	•		Ĺ	16A7
DIS		ΗТ.	' '			-	-	-	•	•	•	•	•	•	В	0002
DIV		•	•	•	•	•	-	•	•	•	•	•	•	•	-	
DIV	/22				-	•	•	-	•	•	•	-	-	•	₿	000B
DIV	/23							-			•		-		В	0038
DIV		_	_	_	_							-			8	000E
DIV		= 1	•	•	٠	-	-	•	-	-				_	D	001D
			•	•	•	•	•	•	•	٠	•	•	•	•	D	001E
DIV			•	•	•	•	•	•	-	•	٠	•	•	-	_	
	٥ ﴿	ΕL	•		•	•	•	•	•	•	•	•	•	•	L	1000
EO3	Ι.	-	•	•	-	•	•	•	•		•	•	•	-	L	TOER

EXH				_	_	_							_		В	0001
FIFO	•	•	•	•	-							-		-	M	OEB4
FILT	- ДШІ	-	[H]	RF	ŠН		_	_							I	0037
FILT	UO.	Ŧ	10	FS	H	•	•	_	_	_	_				I	0080
FIRS	UP.	-''	40		• •	•	•	-	-						L	1220
LIKO	' -	3 <b>1</b> 11	11-	•	-	•	•	•	•	•				_	L	15DB
FLO.	•	•	•	•	-	•	•	-	•	•	•	-			I	000B
FLOT	ΙM	•	•	-	•	•	•	-	•	•	•	•	:	•	В	000F
FLOW	-	•	-	•	-	•	•	-	•	•	•			•	L	160E
FLO_	ALI	٧.	•	•	-	-	•	•	•	•	•	•	•	•	I	002D
FLO_ FLO_	TH	•	-	-	•	•	•	•	•	•	•		-		_	1585
FLO_	TS'	Γ.			-	•	•	-	•				•	-	L	0044
FLTF	LO,	_A\	٧G	•		•	•	-	•	•	•	-	•	-	D	-
FLTF	LO,	_L(	)		-		-	-	•	•	•	•	•	-	D	0040
FLTL	D2	5					-	-	•	•	•		•	-	D	0055
FLTL						-	-						•		D	0056
FI TI	D7	5	_	_	_							-	•	-	D	0057
FLTL	ם ו	- - U⊧	٠ ٧		_									-	D	002C
FLTL	D	יט. זאר	=	•	_	_									D	002E
FLTL	5-	TEN	_	•	•	•	•								D	002D
FLT_	٠ <u>٠</u>	1 51	3	•	-	•	•		:						L	1225
	LU	-	•	•	-	•	•					•			Ĺ	1339
GO_0	N	•	•	•	-	•	•	-	•	•		•	•	:	В	003A
HEAT	•	•	-	•	•	•					•		•		L	1592
HEAT	_CI	ΗK	-	•	-			-						•		11A3
HIPR	ES	S	•	-	-	•	•	-			•					1578
HITE	MP	•	•	-	•	-	-	•	-	•	•	-	•	-	L	
HI_T	EM	Ρ	-		-	•	•	•	-	•	•	-	•	-	L	15AB
HOLD								-		•	-	•	•	•	В	
HOLD	IT		_		-		-		-		-	-	•	-	L	19D5
HOLD	_   	FF	_							-		-			L	170B
HOLD	_0	i T	•		_	_	_	_	_						L	1716
INC3	_0	٠.	•	•	•	•	-			-					L	1336
T T	•										_	_	_		L	1032
INIT	<u> </u>	- . +	7 E	•	•	•	•	-	•	•	-	_	_		L	1030
INTI	TH	L- L-	ے ک	-	•	•	•	•	•	•	•	•	•		_	0015
INSP	`	<u>.</u>	<u>.</u>	•	-	•	•	•	•	•	•	•	•			1639
JUMP	_T	BL	El	•	•	•	•	•	•	•	-	-		•		001C
L14	•	•	•	•	-	•	•	•	•	•	•	•	•	•	В	001D
L15		•	•	-	-	•	-	•	-	•	•	•	-	•	В	001E
L16				-	-	•	•	•	•	•	•	•		-	-	001F
L17	•	•			•	•		•	•	-	•		•	•	В	0034
L24						-	•	-	-	•	•	•	•	•	. B	
L25	-							-	-	-	•	•	-	٠.	В	0035
L26					-			-	-		•	-	•	•	В	0036
L27								-	-	-	•	-	•	-	В	0037
L34	_	_	_					-	-	•	-	-	-	-	В	002C
L35	•	•	-	-	_	_				-	• .	-	-		8	0020
LCD_	vo	·	•	•	•	•	_	_	_						L	1945
	-		•	•	•	•	•	•	_	•	-	_	_		D	0023
LED1		•	•	•	-	•	•	-	•	•	•	_			D	0026
LED2		•	•	•	-	-	•	•	•	•	•	•			D	0025
LED3		<u>.</u> _	•	•	-	•	-	-	•	•	•	•			L	10D8
MAIN	_		Ρ	•	٠	•	٠	•	•	•	-	-	•	•	L	1900
MAN_	-		-	-	٠	•	٠	•	•	•	•	-	•	•	_	154A
NEGF	LO	•		-	-	•	•	•	•	•	-	•	•	•	٦	
NEGS	UM		-					•	•	-	•	•	-	•	D	0051
NEW	TE	MP	_		-		•	•		•	•	-	•	•	L	1699
NEXT				-				-	•	•	٠	•	•	•	L	116D

	2												L	1209
NEXT100		•	•	•	•	•	-	•	•	•	•	•		145D
NEXT100			•	•	•	•	•	•	•			-	_	1486
NEXT100	06	•	•	•	•	•	-	-	-	•	•	•	_	
NEXT100	80												_	14EF
NEXT200	01						-		-	-			L	1185
NEXT200	02	_	_	_		_								12E1
NEXT200		:		•	-	-	-				_		L	1474
NEXT200				•	•	•	•	•	•	•			L	14BD
				•	•		•	•	•	•		•		1506
NEXT200								•			•	٠		16B4
NEXTSUB				•	•					•	•	•		
NEXTSUB							•			•	•	•	<u>_</u>	17B8
NEXTSUB	100	13					•	•	-	•	•	•	L	1903
NEXTSUB	200	11											L	16C1
NEXTSUB:								_	_				L	17C5
NEXTSUB	200	1 7	•	•			•	•			_			1910
						•	•	•	•		•	•		1524
NEXT_SA	MH	•	•	•	•		•	•		•		•	_	15D0
NOFLO .					-		•	-				•		
NOFLOTI	Μ.	-	•	•	•	•				-		•		0032
NOFLO_A	LM	-	-			•	•		-	•			L	15F7
NOFLO_T	н.	_	_	_	_	_	_	_					I	0080
NORMAL.	•••	•	•		•							_	L	198B
NOT SO	•	•	•	•	•		•	•				•	L	1587
NOT_EQ. OFFTIME	_ •	•	•	•	•	•	•	•	•	•	•	:	<u>_</u>	0015
OFFTIME	R.	•	-	•	•	•	•	•	•	•	•		_	000D
OFF_ALM OFF_STA	•	-	-	-	•	-	•	•	•	•	٠	•	В	-
OFF_STA	ΤE	-	-	-	•	•	•	-	-	•	•	•	_	1687
ONTIMER			-		-	-		-		-	-	•		0014
ONTIMER OUT		_										-		13EB
OUT1	•	-	-							_			L	133C
OUTDID.	•	•	•	•	•	•	•	•	-	-			L	1952
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### WHAT IS CLAIMED IS:

A nebulizer comprising:

a housing containing a reservoir for holding a liquid to be nebulized and an air space above the reservoir for holding aerosol;

means for generating said aerosol by nebulizing said liquid;

means for attaching said housing to a mechanical respirator having an inhalation phase, an exhalation phase, a gas flow passageway to a patient, and an external electrical signal source capable of generating a first electrical signal during said exhalation phase;

means responsive to said first electrical signal for introducing said aerosol into said gas flow passageway, such that said aerosol fills said gas flow passageway during a portion of said exhalation phase.

- 2. The nebulizer of Claim 1 further comprising means for monitoring the amount of said aerosol introduced into said gas flow passageway.
- 3. The nebulizer of Claim 1 wherein said mechanical respirator further being capable of generating a second electrical signal during said inhalation phase.
- 4. The nebulizer of Claim 3 wherein said aerosol generating means further comprising a plurality of nebulizer nozzles each having means for controlling the gas flow therethrough.

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5. The nebulizer of Claim 4, wherein said introducing means further comprises:

a gas flow for directing compressed gas from a compressed gas source to each of said plurality of controlling means for said nebulizer nozzles; said gas flow means including means responsive to said first electrical signal for opening a conduit of said nebulizer nozzles and for closing the conduit to said nebulizer nozzles simultaneously or one at a time, in response to said second electrical signal.

6. The nebulizer of Claim 5 further comprising:

means responsive to said second electrical signal for generating a decreasing flow of gas; and

means for directing said decreasing flow of gas into said mechanical respirator.

7. A method of operating a nebulizer of the type having means for generating an aerosol and means for supplying said aerosol to a mechanical respirator having an inhalation phase, an exhalation phase and a gas passageway to a patient, and an external electrical signal source capable of generating a first electrical signal during said exhalation phase, method comprising:

generating said aerosol; and introducing said aerosol into said gas passageway during a portion or all of the said exhalation phase.

8. The method of Claim 7 wherein said introducing step further comprising:

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opening a valve, in response to said first signal, to introduce said aerosol from said nebulizer to said gas passageway.

9. The method of Claim 7 wherein said generating step further comprises:

entraining a liquid into a source of compressed gas to generate said aerosol, in response to said first signal and continuing until standardized volume of aerosol dose has been delivered.

- 10. The method of Claim 7 wherein said external electrical signal source is capable of generating a second electrical signal during said inhalation phase.
- 11. The method of Claim 10 further comprising:

  ceasing the generation of said aerosol in

  response to said second electrical signal.
  - 12. A nebulizer for use with a respirator means having an inhalation phase and an exhalation phase, a first tubing means connecting said respirator means with a patient wherein during said inhalation phase said respirator means is fluidically connected to said patient through said first tubing means for introducing breathing gas in said first tubing means into respiratory tract of the said patient, a second tubing means connecting said respirator means with said patient wherein during said exhalation phase said respirator means is fluidically connected to said patient through said second tubing means for receiving exhaled gas from said patient to said respirator means, said respirator means further

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having means for generating a first electrical signal during said exhalation phase; said nebulizer comprising:

means for generating an aerosol;
aerosol connecting means for connecting
said generating means to said first tubing
means; and

means for introducing said aerosol into said first tubing means in response to and synchronized with said first electrical signal.

13. The nebulizer of Claim 12 further comprising:

housing means containing a reservoir for holding a liquid to be nebulized and an air space above the reservoir for holding said aerosol.

- 14. The nebulizer of Claim 13 wherein said aerosol connecting means connects said air space to said first tubing means.
- 15. The nebulizer of Claim 14 wherein said generating means comprising:

a plurality of nebulizing nozzles each having means for controlling the gas flow therethrough.

- 16. The nebulizer of Claim 15 wherein said respirator means for generating a second electrical signal during said inhalation phase.
  - 17. The nebulizer of Claim 16 wherein said introducing means for all of said nebulizing nozzles, in response to said first electrical signal, de-

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activates said controlling means, either simultaneously or one at a time.

- 18. The nebulizer of Claim 14 further comprising means for monitoring said aerosol introduced into said first tubing means.
- 19. The nebulizer of Claim 16 further comprising:

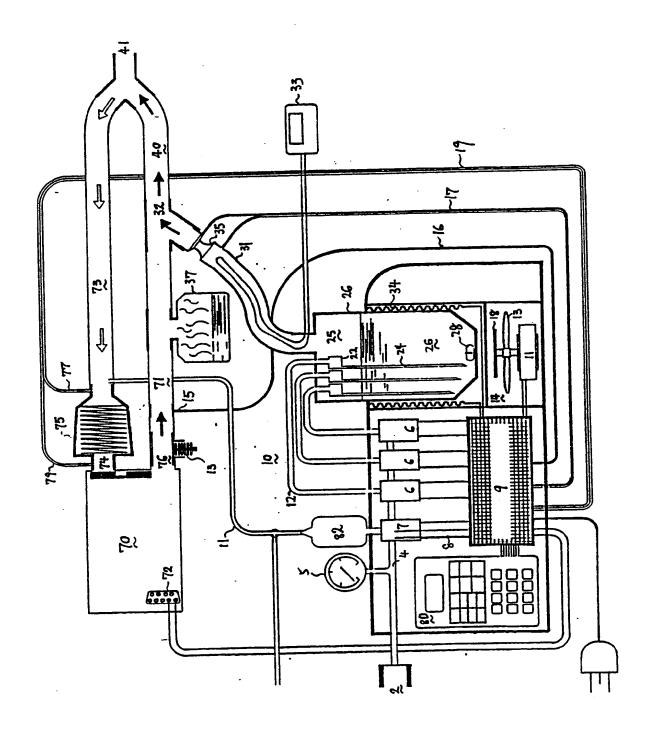
means for generating a decreasing flow of gas; and

10 means for directing said decreasing volume of gas into said second tubing means.

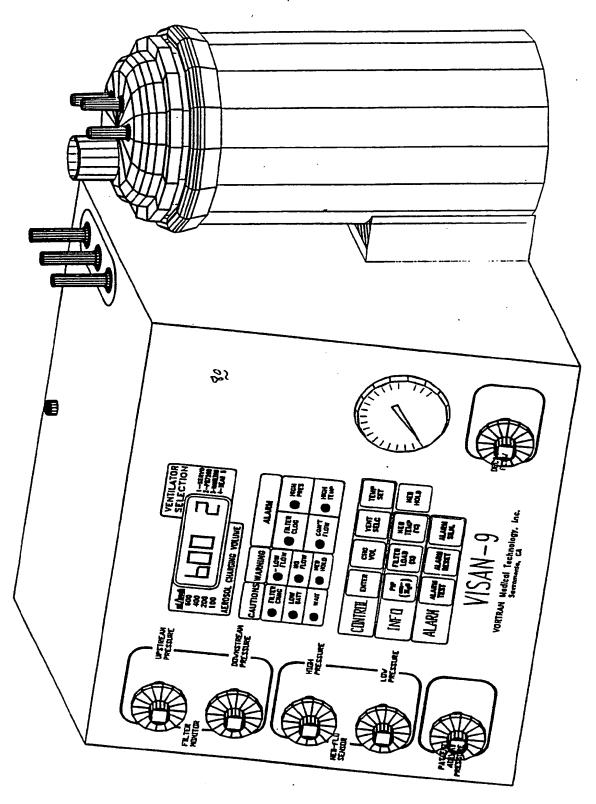
- 20. The nebulizer of Claim 12 wherein said means for generating said first electrical signal further comprises:
- a filter pressure sensor for detecting the pressure differential in said second tubing means, and for generating a filter pressure signal in response thereto;

an airway pressure sensor for detecting the pressure in said first tubing means, and for generating an airway pressure signal in response thereto; and

means for receiving said filter pressure signal and said airway pressure signal and for generating said first electrical signal synchronized with the commencement of said exhalation phase.



FIGURE



FIGURE

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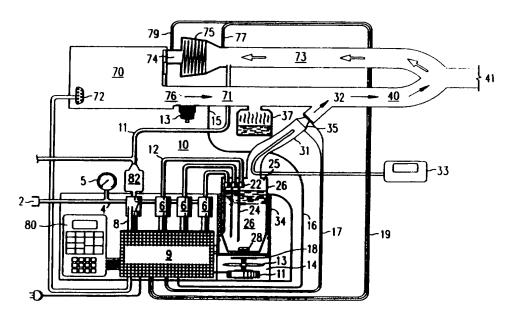
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(54) Title: INTERMITTENT SIGNAL ACTUATED NEBULIZER SYNCHRONIZED WITH EXHALATION



### (57) Abstract

A self-contained, high capacity nebulizer (10), having automatic mixing (28) and temperature control (34) features is provided. The nebulizer is designed for use in conjunction with mechanical respirators (70), ventilators, or breathing machines, and for this purpose will use electrical signals (8) generated by or received from the respirator (70) to automatically control and synchronize the nebulizing and mixing functions such that nebulization occurs only during the exhalation phase of the respiratory function to load the gas passageway of the respirator (70) to the patient with a standardized dose of medicinal aerosol. Upon commencement of the inhalation phase, the aerosol in the gas passageway is ventilated into the lungs of the patient to which it is attached.

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## INTERMITTENT SIGNAL ACTUATED NEBULIZER SYNCHRONIZED WITH EXHALATION

This application is a continuation-in-part of copending U.S. Patent Application Serial No. 07/585,616, filed on September 20, 1990, which is a continuation of U.S. Patent Application Serial No. 270,520, filed on November 14, 1988, now abandoned, which is a continuation of U.S. Patent Application Serial No. 07/071,202, filed on July 8, 1987, now U.S. Patent 4,832,012.

### Technical Field

The present invention relates to nebulizers for creating medicinal aerosols for inhalation therapy. In particular, the present invention relates to nebulizers used during the exhalation phase of the breathing cycle in conjunction with and without interfering with mechanical breathing machines which are used to ventilate the lungs of patients who cannot breathe unaided.

### 20 <u>Background Art</u>

The thin membrane of the lungs provides an easily penetrated, convenient and generally safe means for obtaining rapid absorption of medication by the body. This is especially desirable where the lungs themselves are diseased or injured. Such medication or drugs are generally delivered to the lung membrane in the form of a fine mist or aerosol which is breathed into the lungs through the nose or mouth of the patient. A variety of devices, called nebulizers by those skilled in the art, have been developed for converting liquids into fine aerosols

-2-

for this purpose. The simplest of these devices is the hand-held atomizer which converts a liquid to an aerosol when a bulb is compressed to produce a jet of air which atomizes the medication and propels it out of the atomizer. To be effective, the aerosols need to be provided at high concentrations and with droplet size in the respirable range (mass median aerodynamic diameter less than 3 micrometers).

Nebulizers are particularly useful for initiating and continuing respiratory therapy in conjunction with respirators, mechanical ventilators or breathing machines (hereinafter referred to generically as respirators) used to ventilate the lungs of patients having serious respiratory impairment. While some respirators incorporate nebulizers in their design, many do not. Nebulizers incorporated into the structure of such respirators often suffer from many disadvantages. One such disadvantage is severely limited capacity for medication to be nebulized, requiring frequent interruptions in the therapy as new medication is added to the nebulizer reservoir.

Most, if not all, such nebulizers are incorporated in respirators in which the inhalation and exhalation phases of the breathing cycle are triggered by changes in air pressure caused by the patient himself. Such "demand" respirators are not useful for patients whose respiratory systems are paralyzed and incapable of causing even slight changes in air pressure. These patients are aided by mechanical respirators in which the phases of the breathing cycle are triggered by electrical signals. There is now no effective means for patients on such respirators to receive aerosol treatment.

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Thus, the need exists for a nebulizer which can be attached to a mechanical respirator, especially those in which the breathing cycle is controlled by an electrical signal, which has a reservoir capacity sufficient to enable several hours of continuous treatment, which can prevent the settling of suspensions or mixtures without creating nebulization-destroying turbulence.

U.S. Patent 4,832,012 discloses the principal of signal actuated synchronization of nebulization for delivery of aerosolized medicine to patients whose breathing is supported or augmented by a mechanical respiratory. In that reference, nebulization could be effected during inhalation or exhalation, but the primary trust of that reference was to provide aerosols during the inhalation phase of the breathing cycle to mix with the inhalation tidal volume provided by the respirator, and in synchrony with the normal operation of the respiratory. However, it has been found that the addition of volume of gas to mix with the inhalation tidal volume provided by the respirator, may interfere with the normal operation of the respirator in certain operating modes, and the medicinal aerosol is diluted by the portion of gas delivered by the respirator.

### Summary of the Invention

The present invention is based upon the nebulization of medicine during and synchronized with the exhalation portion of each breath of the breathing cycle to fill the airline leading from the nebulizer to the patient with a standardized dose of medicinal aerosols that are delivered to the lung by the force of the flow of breathing gas (oxygenenriched air) delivered by the respirator during the

-4-

inhalation portion of the breathing cycle. One advantage of this invention is that more concentrated standardized dose of aerosol is delivered to the patient with the first parcel of gas that enters the lungs for each breath during the inhalation process. In addition, the signal used to actuate the nebulizer may be obtained from the ventilator or from an independently generated signal established by the nebulization system utilizing the readily detected respiratory air line pressure or pressure drop across filter from exhaled gas flow. Also, certain safety monitoring features are incorporated into such a system to detect aerosol clogging of respiratory filters and prevent interference with the normal operation of the respirator.

The nebulization system of the present invention can be attached to or operated with a mechanical respirator utilizing either a breathing cycle electrical signal obtained from the respiratory or an independent electrical signal generated by the nebulizer system which detects and responds to the exhalation initiation of the respirator. synchronized signal actuated nebulizer system is designed to operate during the exhalation phase of the breathing cycle while treating a sick patient and efficiently providing, in the short time available, a medicinal aerosol in the appropriate and desired volume, concentration, and particle size distribution for deposition in the respiratory airways of the An important feature of such a system is that all of the aerosol is generated quickly (in about 1 second or less) and in a way that does not interfere with the control system of the respirator. nebulizer system has a reservoir of capacity sufficient to enable several hours of continuous

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treatment and with provision to prevent the settling of suspensions or mixtures without creating nebulization-destroying turbulence, and provides a precisely measured volume of medicinal aerosol generated during patient exhalation in a manner to reach the patient at the precise moment when inhalation begins.

In one embodiment, the present invention provides a nebulizer for use with mechanical respirators which use electrical signals to control the breathing cycle. The nebulizer of this embodiment uses the existing electrical signals from the mechanical respirator to synchronize aerosol generation to fill the gas passageway from the respirator to the patient during the exhalation cycle. Upon the initiation of the inhalation cycle, the aerosol is delivered from the gas passageway to the patient. Nebulization is obtained in this embodiment using the premixed oxygen-enriched air provided at high pressure to the respirator. Automatic temperature regulation and stirring of the liquid medication is optionally provided to preclude concentration change, separation or settling of the medication. Finally, a large volume reservoir is provided to eliminate the need for refilling during lengthy treatment protocols.

### Brief Description of the Drawings

Figure 1 is a schematic side view of a nebulizer of the present invention operationally attached to a mechanical respirator;

Figure 2 is a perspective view of the intermittent signal actuated system of the present invention.

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### Detailed Description of the Invention

Figure 1 shows a nebulizer apparatus 10 of the present invention operably connected to a mechanical respirator 70. The nebulizer apparatus 10 comprises, in a housing, compressed gas inlet 2, at one end of a compressed gas conduit 4, adapted to be connected to a compressed gas source at pressure indicated by gauge 5. Preferably this compressed gas source is the same source which is furnishing oxygen-enriched air to the respirator 70, and provides compressed air or oxygen mixture to the nebulizer ranging up to about 50 psig.

Compressed gas conduit 4 is connected at the other end to a first electrically operated nebulizer valve 7, and a plurality of second electrically operated nebulizer valves 6, all of which are substantially similar. Examples of such valves which have been found useful include the Honeywell Skinner K4M ultraminiature 4-way solenoid operated pneumatic valve and Numatics HS series 2-way solenoid operated valves. Three valves 6 are shown in Figure 1.

Nebulizer valves 6 and 7 are connected by a plurality of electrical lead wires 8 to a microprocessor 9 and are controlled by the microprocessor 9. The microprocessor 9 receives the signals from a signal source 72 on the respirator 70 which controls the inhalation/exhalation phase of the breathing cycle. The microprocessor 9 controls the valves 6 and 7 to provide for a safe and effective operation. Examples of signal source 72 include a respirator solenoid, such as a solenoid actuated inhalation valve, an external electronic monitoring system, or an electronic interface attached to a signal generator on respirator 70, such as an

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interface connected to a logic circuit in the respirator.

A control unit 80, whose control panel is shown in Figure 2, is connected to the microprocessor 9. The control unit 80 controls the functions of the nebulizing apparatus 10 of the present invention.

Each of the nebulizer valves 6 connects the compressed gas source 4 to nebulizer conduits 12 leading to aerosol nozzles 22. Each nebulizer valve 6 switches between two positions as electrical on/off signals are received. In the first position, during the exhalation phase of the respirator 70 when the electric signal is "on", a passageway is opened between compressed gas conduit 4 and nebulizer conduits 12 and remain open until the desired aerosol volume has generated or until the inhalation phase is initiated by the respiratory 70 as controlled by microprocessor 9. In the second position, when the electric signal is "off", the nebulizer conduits 12 are sealed off.

Nebulizer conduits 12 are attached at their other ends to aerosol nozzles 22, which include liquid feed tubes 24 extending into reservoir 26. Reservoir 26 includes magnetic stirring bar 28 which is located in the bottom of the reservoir. The liquid medicine contained in reservoir 26 is preferably kept at constant temperature by a reservoir heater or cooler 34.

A chamber 14 houses an AC motor 11 which rotates a cooling fan 13 and a magnet 18. The rotation of the magnet 18 causes the stir bar 28 to rotate to prevent sedimentation or separation of medicinal constituents.

The liquid medicine in the reservoir 26 is drawn via the liquid feed tubes 24 and is converted by the

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aerosol nozzles 22 into an aerosol having droplets with a mass median aerodynamic diameter less than about 3 micron. The aerosol is generated into the air space 25 above the reservoir 26. The aerosol generated in the air space 25 enters into an aerosol tube 31.

The temperature of the aerosol in the aerosol tube 31 is controlled by a temperature controller 33. In one embodiment, the temperature controller is simply an electric heater having a control unit. Within the aerosol tube 31 is also a neb-flow sensor 35. The neb-flow sensor 35 detects the amount of aerosol being delivered through the aerosol tube 31. The output of the neb-flow sensor 35 is supplied as a signal to the microprocessor 9 via neb-flow sensor pressure/vacuum lines 17.

The respirator 70 has an inhalation tube 71 and an exhalation tube 73. The inhalation tube 71 fluidically connects the respirator 70 to a patient and during the inhalation phase, breathing gas is supplied from the respirator 70 along the inhalation tube 71 into the respiratory tract of the patient. The aerosol tube 31 connects the air space 25 above the liquid 26 to the inhalation tube 71 at a nebulizer input 30. In addition, a pop-off valve 13 is also located in the inhalation tube 71. function of the pop-off valve 13 is to relieve any pressure which is generated to dangerous levels within the inhalation tube 71. It functions purely as an emergency safety valve. Finally, an airway pressure sensor 15 is also positioned in the inhalation tube 71. The airway pressure sensor 15 generates a signal which is also supplied to the microprocessor 9 via airway pressure monitoring line 16. A humidifier 37 whose output is water vapor

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mixed with the breathing gas is also connected to the inhalation tube 71.

The exhalation tube 73 fluidically connects the patient to the respirator 70. Located within the exhalation tube 73 is an exhalation filter 75.

Upstream from the exhalation filter 75, i.e., between the exhalation filter 75 and the patient is an upstream filter pressure sensor 77. Downstream from the exhalation filter 75, i.e., between the exhalation filter 75, i.e., between the exhalation filter 75 and the ventilator 70 is a downstream filter pressure sensor 79. The upstream filter pressure sensor 77 and the downstream filter pressure sensor 79 each provide a signal which is supplied to the microprocessor 9.

The solenoid 7 is also connected to receive gas from the gas conduit 4 and is adapted to supply gas to a decay flow line 11 to the exhalation tube 73, upstream from the upstream filter pressure sensor 77. Thus, the solenoid 7, when activated, provides a stream of compressed gas which is supplied into the exhalation tube 73, between the patient and the upstream filter pressure sensor 77. The function of the decay solenoid 7 is also controlled by the microprocessor 9.

The operation of the nebulizer apparatus 10 of the present invention will be understood as follows. The practitioner first determines the amount of volume per breath of the standardized dose of aerosol which is to be generated by the apparatus 10 of the present invention which is to be supplied to the inhalation tube 71. The amount is entered on the control unit 80. The microprocessor 9 receives the signal and based upon its knowledge of the gas pressure from the compressed gas conduit 4, and the cross-sectional area of each of nebulizing nozzles

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22, the microprocessor 9 calculates the amount of time which the solenoids 6 would have to be activated in order to introduce the desired amount of aerosol into the inhalation tube 71. Alternatively, the signal from the neb-flow sensor 35 is used by the microprocessor 9 to turn off the nebulizer solenoids 6 when the desired charging volume has been generated.

When the mechanical respirator 70 begins the exhalation phase of the respiratory cycle, electrical signal 72 supplies the signal to the microprocessor 9. (As will be discussed hereinafter, a number of other signals are supplied to the microprocessor 9 to indicate the beginning of the exhalation cycle. These additional signals are used in the event the ventilator 70 cannot provide the electrical signal source 72 or is used as a safety backup to the electrical signal source 72.) When the mechanical respirator 70 begins the exhalation phase, the inhalation port 76 is closed. The exhalation port 74 is opened, opening the exhalation tube 73.

After the electrical signal source 72 generates the signal indicating the beginning of the exhalation phase, the microprocessor 9 activates the solenoids 6 to the three nebulizing nozzles 24. Thus, after the commencement of the exhalation phase, and after the detection of the electrical signal, maximum generation of the aerosol from the apparatus 10 commences and continues until the standardized volume or dose of aerosol has been generated. Compressed gas flows through the compressed gas conduit 4 into the three nebulizer conduits 12 and into the nozzles 22, which draw liquid via liquid feed tube 24 from the liquid reservoir 26. The aerosol is then generated and is supplied into the air space 25 above

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the reservoir 26. The aerosol generated in the air space 25 then enters into the aerosol tube 31 where the temperature thereof is controlled by the temperature controller 33. The aerosol then leaves the aerosol tube 31 and enters into the inhalation tube 71 through port 30. Generation of the standardized dose of aerosol fills the charging volume space 40 between the nebulizer input port 32 and the patient 41 in the inhalation tube 71. Any excessive aerosol will enter the exhalation tube 73 and return to the respirator 70.

During the exhalation phase, the pressure in the inhalation tube 71 is monitored by the airway pressure sensor 15 and is supplied to the microprocessor 9. This provides a safety signal to the microprocessor 9 to shut off the function of the aerosolization in the event pressure within the inhalation tube 71 builds to an excessive level or if inhalation begins. In addition, a mechanical safety pop-off valve 13 is provided wherein in the event the pressure in the inhalation tube 71 exceeds the pressure regulation of the pop-off valve 13, the valve 13 would automatically open relieving the pressure in the inhalation tube 71.

During the exhalation cycle, the respirator 70 continuously monitors the pressure on the exhalation tube 73. In order to provide for a smooth decay flow of gas entering into the exhalation tube 73 from the patient, and thereby simulating smooth exhalation reduction from the patient, the solenoid 7 is activated during the exhalation cycle. When the solenoid 7 is activated, the gas from the compressed gas conduit 4 fills a fixed volume chamber 82. The fixed volume chamber 82 has a calibrated orifice which is connected to the decay flow line 11 and is

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supplied to the exhalation tube 73. During the time period in which the aerosol is being generated, the fixed volume chamber 82 is filled with breathing gas to a predetermined pressure. At the end of the charging period, the compressed gas from the gas conduit 4 is turned off. The gas from the fixed volume chamber 82 is then allowed to flow in a decay manner into the exhalation tube through the orifice connecting the chamber 82 to the decay flow line 11. When the pressure in the fixed chamber 82 gradually reduces, the flow entering the decay flow line 11 simulates a natural first order decay.

Synchronous with the beginning of the exhalation cycle, the three nebulizing nozzles 22 are turned on simultaneously or one at a time to produce the desired charging volume during a portion of the exhalation period to allow the respirator 70 to maintain and/or support the patient's spontaneous breathing effort without interference from the charging flow.

When the respirator 70 begins the inhalation phase of the respiratory cycle, the electrical signal source 72 switches to an "off" position. In the "off" position, the respirator inhalation port 76 opens; the respirator exhalation port 74 is closed.

The solenoid valves 6 are controlled by microprocessor 9 when first, the desired standardized dose is reached (usually only takes a portion of the exhalation phase), or secondly when microprocessor 9 detects the electrical signal source 72 turn to an "off" position. In the first priority, the solenoids 6 can be turned off one at a time. In the second case, the solenoids 6 are turned off immediately to allow respirator 70 to begin the inhalation phase.

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The gradual turning off of the plurality of solenoids 6 generates a gradual pressure reduction and flow shaping that prevents spurious triggering of the respiratory ventilator 70 caused by rapid flow Because the aerosol generated by the apparatus 10 of the present invention fills the inhalation tube 71 between the nebulizer input 30 and the patient with the desired standardized volume or aerosol dose, when the ventilator 70 begins the inhalation phase and pushes the gas in the inhalation tube 71 into the respiratory tract of the patient, the aerosol in the charging volume space 40 would be the first gas pushed into the lungs of the patient. Thus, the medicine produced by the aerosol would be first delivered to the patient during the inhalation cycle.

The advantage of the apparatus 10 and method of the present invention is that generating the aerosol and introducing it into the charging volume space 40 during the exhalation phase means the aerosol is precharged in the inhalation tube. Further, the amount of aerosol in the charging volume space 40 can be metered or controlled by the microprocessor 9. In addition, the introduction of aerosol during the exhalation phase does not perturb the pressure of the gas from the respirator 70 delivered during the inhalation phase.

As previously discussed, the source of electrical signal 72 may not be provided by all ventilators 70. The upstream filter sensor 77 and the downstream filter sensor 79 each provides a signal via the exhalation filter sensor pressure/vacuum lines 19, the difference of which indicates the commencement of the exhalation phase. Thus, upon the immediate commencement of the

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exhalation phase, a pressure differential would be detected between the upstream filter sensor 77 and the downstream filter sensor 79, respectively. This pressure differential, supplied as a signal to the microprocessor 9, would indicate to the microprocessor 9 that the exhalation cycle has commenced. This signal can be used by microprocessor 9 to begin nebulization when no respirator electrical signal is available. Alternatively, the airway pressure sensor 15 supplies a signal to the microprocessor 9 indicating the beginning of the exhalation and also the beginning of the inhalation for control of the nebulization by microprocessor 9 when no respirator electrical signal is available.

In addition, there are many safety considerations with the apparatus 10 of the present invention. With the upstream and downstream filter sensor 77 and 79 respectively having an exhalation filter 75 therebetween, the condition of the exhalation filter 75 can be continuously checked. As the apparatus 10 of the present invention is continuously used, and as the filter 75 becomes increasingly clogged, the pressure differential between the upstream filter sensor 77 and the downstream filter sensor 79 would increase. Alternatively, the loading/clogging of the exhalation filter can be detected using the airway pressure sensor 15 which supplies a signal to microprocessor 9 via line 16. This is because airway pressure during nebulization is a function of the resistance of the exhalation filter. The filter loading/clogging can be detected by the microprocessor 9 and can be signaled on the control unit 80 as an alarm that the exhalation filter 75 needs to be examined and/or changed.

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As previously discussed, the airway pressure sensor 15 provides an independent airway pressure measurement upstream to exhalation filter to monitor the patients safety. Finally, the control unit 80 can control the apparatus 10 to cause it to pause its operation. This provides an independent check on the respirator system 70. The control unit shown in Figure 2 provides for setting of charging volume, respirator selection (for different commercial respirators), heater temperature, nebulizer hold option, alarm test option, alarm reset, and alarm silence. Further, the control unit displays respirator selection, charging volume, alarm, warning, and caution, indication of exhalation filter loading, patient peak inspiratory pressure, heater temperature and nozzle gas pressure. Signals from the neb-flow sensor 35 are used to alarm if either inadequate charging volume is generated or if the nebulizer nozzle 24 malfunction in the "on" position. The microprocessor 9 provides yet additional safe and effective operation for the apparatus 10 of the present invention. In the preferred embodiment, the microprocessor 9 is an Intel 8751 available from Intel Corporation. A copy of the program, written in the assembly language, for execution by the microprocessor 9 is attached as Exhibit A.

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:VISANS
               STITLE SAMPLE SIGNALS AND CONTROL VISAN 9
                :SAMPLE VENTILATOR ANALOG SIGNAL AND
                :PRESSURE AND FLOW SIGNALS FROM NEBULIZER
                :AND CONTROL 3 NEBULIZER VALVES.
                :CONTROL SERIAL INTERFACE WITH OPERATOR
                :SWITCHES AND DISPLAYS.
               FLOTIM EQU 11 :TIME=2.25
= 8000
               NOFLOTIM EQU 50 :TIME=105
0032 =
               FLO_TH EQU 45 :FLO 18LPM.0.14CMWC.0.17V.2DH
002D =
               NOFLO_TH EQU 140 :FLO 35LPM,1.12CMWC,0.5V,8CH
008C =
                PIP_THRESH SET 120*8/5+32 ;THR=4.4V,E0H,120CM
00E0 =
               FILTAWP_THRESH EQU 55 :PRES=34CM.1.07V.37H
0037 =
                FILTDP_THRESH EQU 141 :PRES=5.5CM.2.75V.8DH
0080 =
                PATINSP_THRESH SET 5*8/5 ; PEEP-AWP= 5 CM WC
0008 =
                TEMP_HI SET BO*2 :UPPER LIM BOC.AOH
00A0 =
                FSEG
0000
                                   : BANKO
                ALTHAME RI.RVENT_SIG : VENTILATOR SIGNAL
0001 =
                ALTHAME R2.RFLT_FLO ; EXH FILT DP SIGNAL
0002 =
                ALTHAME REST PRESS SAWP TAP AT VENT
0003 =
                ALTNAME R4.RNEB_FLO ; NEB OUTPUT DP
0004 =
                ALTHAME RS.RTEMP : TEMP DEG C * 2
0005 =
                                  : VENTILATOR # SELECTED
                ALTHAME RG.RVENT
0006 =
                                   :BANK1
                ALTNAME R1.RCHG_TIM ; NEB CHARGE TIME
0001 =
                ALTHAME R2. RDIV10 : TIMER DIV BY 10
0002 =
                ALTHAME R3. RDIV5 :TIMER DIV BY 5
ALTHAME R4. RON_TIM :NEB FLOW ON TIME
0003 =
0004 =
                ALTNAME RS.ROFF_TIM : NEB FLOW OFF TIME
0005 =
                ALTNAME R6.RSIL_TIM ; AUDIO OFF TIME
0006 =
                ALTNAME RT. RHOLD_TIM ; NEB OFF TIME
0007 =
                ENDS
0000
                DSEG
0000
                LEDI DATA 23H : LED BANKS
0023 =
                LEDZ DATA 26H
0026 =
                LEDS DATA 25H
0025 =
                CHG_VOL DATA 28H :HUNS DEC DISPLAY
0028 =
                DEC_HUN DATA 29H :NUMBER FOR DISPLAY DEC_TEN DATA ZAH
0029 =
002A =
0028 =
                DEC ONE DATA 28H
                FLTLD_HUN DATA 2CH :FILTER LOAD SETTING
0020 =
                FLTLD_TEN DATA 2DH : 25%, 50% OR 75%
002D =
                FLTLD_ONE DATA ZEH
002E =
                THREE_CYCLE DATA 2FH : THREE BREATH COUNTS
002F =
                FLTFLO_LO DATA 40H : RUNNING AVG CALC
0040 =
                FLTFLO_AVG DATA 44H
0044 =
                CLOG_LO DATA 45H
0045 =
                CLOG_HI DATA 46H
0046 =
                AWP_LO DATA 48H
0048 =
                AWP AVG DATA 4CH
004C =
                AWP_MAX DATA 4DH
004D =
```

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```
PIP STORE DATA 4EH
004E =
                POSSUM DATA SOH ; NEB POS SUM
0050 =
                NEGSUM DATA 51H ; NEB NEG SUM
0051 =
               FLTLD25 DATA 55H : PERCENT FILTER LOAD
0055 =
                FLTLDSO DATA 56H
0056 =
                FLTLD75 DATA 57H
0057 =
                PIP_LO DATA 58H
PIP_AVG DATA 58H
0058 =
005B =
0060 =
                PEEP_LO DATA SOH
                PEEP_AVG DATA 63H
0063 =
                TEMP_SET DATA 11H
0011 =
0012 =
                TEMP_DEC DATA 12H
                ONTIMER DATA 14H
0014 =
                OFFTIMER DATA 15H
0015 =
                SET CHGTIM DATA 19H : CONTROLS CHARGE VOL
0019 =
                VENT_LO DATA LAH :LOWER THRESH
001A =
                                      :UPPER THRESH
                VENT_HI DATA 18H :UPPER THRESH
TEMP_STORE DATA 1CH :TEMPORARY -STORE
001B =
001C =
                DIVIDEL DATA 1DH : TRANS_DEL
001D =
                DIVIDE2 DATA 1EH
001E =
                VENT_LOW DATA 68H
VENT_AVG DATA 6CH
0068 =
0060 =
                ENDS
9200
                BSEG
0000
                WAIT BIT OH :FIVE BREATH WAIT
0000 =
                EXH BIT 1H : EXHALATION PERIOD
0001 =
                DIV21 BIT 2H :TIMER
9002 =
                VOL_CHG BIT 3H : OP CHANGING VOL SET
0003 =
                VEN_SEL BIT 4H : OP SELECTING VENTILATOR
0004 =
                BEEP BIT 14H ; AUDIO ON/OFF
0014 =
                SIL BIT 6H ; TWO MIN SILENCE
0006 =
                SPON BR BIT 7H ; PATIENT BREATH
0007 =
                HOLD BIT BH ; NEB OFF
- 8000
                SEE_PIP BIT O9H :DISPLAY PIP
0009 =
                DIV22 BIT OBH :TIMER
000B =
                ALM BIT OCH : AUDIO ALM SET
0000 =
                OFF_ALM BIT ODH :BLINK_BEEP
000D =
                 ALM_TST BIT OAH "SET DURING TEST
= A00C
000E =
                DIV24 BIT OEH :START DELAY
                FLOW BIT OFH : NEB FLOW ON
000F =
                SEE_TEMP BIT 10H
SEE_LD BIT 11H
9910 =
0011 =
                 DELI BIT 12H
0212 =
                 DEL_4TENTHS BIT 13H :TIMER
0013 =
                 INSP BIT 15H : INSP TIME
0015 =
                 CLOG1 BIT 16H : COUNT FLT LD SAMP
0016 =
                 CLOG2 BIT 17H
0017 =
                L14 BIT 1CH :LO BAT
L15 BIT 1DH :FILTER CHANGE
                                              LEDI
0010 =
001D =
                L16 BIT 1EH :WAIT 5 CYCLES
001E =
                L17 BIT 1FH ;LO FLOW
001F =
                                               LED2
                L24 BIT 34H :NO FLOW
 0034 =
                 L25 BIT 35H :NEB HOLD
 0035 =
                 L26 BIT 36H :FILT CLOG
0036 =
```

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```
L27 BIT 37H : CONT FLOW
0037 =
               L34 BIT 2CH :HI PRESS
                                             LED3
0020 =
               L35 BIT 20H :HI TEMP
0020 =
               DIV23 BIT 38H :TIMER
0038 =
               CLK BIT 39H :TIMER 0.25
HEAT BIT 3AH :HEATER ON
0039 =
003A =
                TEMP BIT 38H
003B =
                ENDS
0025
                CSEG
0000
                 : MACRO DEFINITIONS
                                       :ANALOG-DIGITAL CONVERSION
                ANALOG MACRO SAVE
                     :DELAY TIME FOR MUX
                NOP
                NOP
                NOP
                NOP
                 NOP
                 CLR P2.3 :START CONVERSION
                         :ALLOW CONV. TIME'S MICROSEC
                 NOP
                 NOP
                 NOP
                                SAVE DIGITAL OUTPUT
                 MOV SAVE.P1
                 SETB P2.3
                 ENDM
                 RUNNING_AVG MACRO LODATA, N. INSIG, AVG
                 CALCULATES RUNNING AVERAGE OF N BYTES IN DATA MEMORY WITH A LOW ADDRESS OF LODATA. INPUT SIGNAL IS LOCATED
                 :AT INSIG. AVERAGE OUTPUT IS AT AVG.
                 PUSH PSW
                 PUSH ACC
                 PUSH 8
                 CLR PSW.3 :BANKO
                 CLR PSW.4
                 MOV A. #LODATA :SET RO
                 ADD A.#N
                 DEC A
                 MOV RO.A
                 NEXT1:
                 DEC RO
                              :SHIFT UP
                 MOV A.GRO
                 INC RO
                 MOV PRO.A
                 DEC RO
                 CJNE RO. #LODATA.NEXT1 :LODATA ADDRESS
                 MOV A. INSIG : MOV NEW DATA TO LODATA
                 MOV B. #N
                 DIV AB
                 MOV @RO.A
                 MOV A, #LODATA : ADD TO CALC AVG
                 ADD A.#N
                 DEC A
```

#### SUBSTITUTE SHEET

MOV TEMP\_STORE.A

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```
MOV A. GRO
XCH A.RO
NEXT2:
XCH A.RO
INC RO
ADD A. GRO
XCH A.RO
CJNE A. TEMP_STORE, NEXT2
XCH A.RO
MOV AVG.A
POP B
POP ACC
POP PSW
ENDM
FIFO MACRO NEW_IN.N1.NEW_DATA
REGISTER STORES SUCCESSIVE DATA FIFO
FROM NEW_DATA SOURCE INTO REGISTER ADDRESS
:NEW_IN. NI IS THE NUMBER OF DATA STORED.
CLR PSW.3
           :BANKO
CLR PSW.4
 MOV A. #NEW_IN :SET RO
 ADD A, #N1
 DEC A
 MOV RO.A
 NEXT3:
 DEC RO
 MOV A. GRO : SHIFT UP
 INC RO
 MOV GRO.A
 DEC RO
 CJNE RO. #NEW_IN.NEXT3 : NEW_IN ADDR
 MOV NEW_IN . NEW_DATA
 ENDM
 BINARY_BCD MACRO HUN, TEN, DNE
 CONVERTS BYTE LOCATED IN ACC TO DECIMAL
  AND STORES RESULT IN HUN, TEN AND ONE.
 MOV HUN. #0 : CLEAR REGISTERS
 MOV TEN. #Q
  MOV ONE,#6
 CALC_HUN: ::SUBTRACT 100
  MOV B.A
  NEXTSUB1:
  CLR C
  SUBB A.#100
  JC CALC_TEN
  INC HUN
           : SAVE
  MOV B.A
  SJMP NEXTSUB1
  CALC_TEN: ::SUBTRACT 10
  MOV A.B
  NEXTSUB2:
  CLR C
  SUBB A.#10
  JC CALC_ONE
```

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```
INC TEN
                MOV B.A
                SJMP NEXTSUB2
                CALC_ONE:
                MOV ONE.B
                MOV A.HUN
                JNZ BCD_OUT
                MOV HUN. #OFH
                                :BLANK
                MOV A.TEN
                JNZ BCD_OUT
                               :BLANK
                MOV TEN, #OFH
                BCD_OUT:
                ENDM
                ORG 1000H
1000
                 : %S
                BEGIN:
                AJMP INITIALIZE
1.000 0130
                ORG 1003H : MANUAL SWITCH INT .. INTO
1003
1003 0219CC
                LJMP MAN_SW
                 ORG 1008H :TIMER 0 INT.,TFO
1008
                AJMP TIM_SAMP
100B 61F3
                 ORG 1013H : LOW BATTERY INT. INT1
1013
                CLR IE1
1013 C288
1015 D21C
                 SETB L14
                 MOV SBUF. LED1
1017 852399
                 ACALL TRANS_DEL
101A D125
                 RETI
101C 32
                 ORG 1030H
1030
                 INITIALIZE: ::SET REGISTERS
                 SETB DELL
1030 D212
                 INIT1:
                 ANL PCON. #OOH : SMOD = 0
1032 538700
                 MOV THOD . #00100000B ; TIME 1 MODE 2. TIME 0 MODE 0
1035 758920
                 MOV SCON.#01010000B : SERIAL PORT MODE 1
1038 759850
                 MOV THO, #70H :SET TIMER
1038 758070
                 MOV TH1. #OFDH : BAUD RATE 9600
MOV P2. #78H ; OUTPUTS OFF
103E 758DFD
1041 75A078
1044 75A887
                 MOV IE.887H :ENABLE EX1.ETO.EXO
MOV IP.802H :FIRST PRIORITY TIMER O
1047 758802
                 MOV TOON, #50H :TIMERS ACTIVE, IT1 & IT0
104A 758850
                                 :LOW LEVEL TRIGGGER
                 MOV PO. #OOH
104D 758000
                 MOV SP. #30H : STACK ADDRESS
 1050 758130
                 MOV 20H. #OOH :CLEAR BITS
 1053 752000
                 MOV 21H.#00H
 1056 752100
                 MDV 22H, #00H
 1059 752200
                 MOV 27H,#00H
 105C 752700
                 SETB PSW.3
                                  :BANK1
 105F D2D3
                                 :R3
 1061 7BC5
                 MOV RDIV5.#5
                 MOV RDIV10.#10 :R2
 1063 7A0A
                 MOV RSIL_TIM.#120 :R6.DEL 2 MIN (3CH)
 1065 7E78
                 MOV RHOLD_TIM.#120 :R7
 1067 7F78
```

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```
MOV ROFF_TIM.#NOFLOTIM :R5. CLEAR REGISTER
MOV RON_TIM.#FLOTIM :R4
MOV RCHG_TIM.#0 :R1
1069 7032
106B 7C0B
106D 7900
106F 751532
                MOV OFFTIMER. #NOFLOTIM
1072 751408
                MOV ONTIMER, #FLOTIM
1075 755000
                MOV POSSUM.#0
1078 755100
                MOV NEGSUM. #0
1078 751128
                MOV TEMP_SET.#40 :DEFAULT
                MOV FLTLD_HUN.#OOH
MOV FLTLD_TEN.#O1H
MOV FLTLD_ONE.#O2H
107E 752C00
1081 752D01
1084 752E02
                                       :TRANS DEL
1087 751DFF
                MOV DIVIDE1.#OFFH
                MOV DIVIDE2.#04H
108A 751E04
108D 0202
                SETB DIV21
                             :TIMER
108F 020B
                SETB DIV22
                MOV VENT_HI.#45H ; THRESH = 2.7V/2 = 1.35V
MOV VENT_LO.#38H ; THRESH = 2.3V/2 = 1.15V
1091 751845
1094 751A38
1097 751928
                HOV SET_CHGTIM.#40 ;CASE8 GIVES: 60
                                 :BANKO
1094 C2D3
                CLR PSW.3
1090 7E13
                MOV RVENT, #13H :R6.VENT #
                MOV SBUF, RVENT
109E 8E99
                ACALL TRANS_DEL
10A0 D125
                                  :WAIT LED ON
10A2 752344
                MOV LEDI,#44H
10A5 852399
                MOV SBUF, LED1
10A8 D125
                ACALL TRANS_DEL
10AA 752605
                MOV LED2.#05H
                MOV SBUF, LED2
10AD 852699
1080 D125
                 ACALL TRAMS_DEL
                MOV LEDJ. #06H
MOV SBUF, LEDJ
1082 752506
1085 852599
                ACALL TRANS_DEL
1088 D125 .
108A 752840
                MOV CHG_VOL.#40H :CASE8 GIVES 600ML
108D 301212
                 JNB DEL1.CONTS
10C0 C212
                CLR DEL1
10C2 C20B
                 CLR DIV22
                 CLR DIV24
10C4 C20E
                 DELAY1: JB DIV24.DELAY2
10C6 200E02
1009 80FB
                 SJMP DELAYI
10CB 300E02
                 DELAY2: JNB DIV24.END_DEL
LOCE BOFB
                 SJMP DELAY2
1000 0132
                 END_DEL: AJMP INITI
1002 121765
                 CONTS: LCALL CASE81
1005 00
                 NOP
1006 00
                 NOP
1007 00
                 NOP
                 MAIN_LOOP: :: INSP/EXP CYCLE
                 LCALL SERVICE
1008 12156E
1008 200C$1
                 JB ALM.ALARM
10DE 02D3
                 CLR PSW.3 :BANKO
10E0 CZD4
                 CLR PSW.4
10E2 E518
                 MOV A. VENT_HI : WAIT FOR SOI
10E4 C3
                 CLR C
10E5 9560
                 SUBB A. VENT AVG :R1
                 JNC MAIN_LOOP : ?NOT INSP
10E7 50EF
```

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```
10E9 D215
                SETR INSP
                EDI: :: WAIT FOR EDI
 10EB 12156E
                LCALL SERVICE
 10EE 200C3E
                JB ALM ALARM
 10F1 E51A
                MOV A. VENT_LO
10F3 C3
                CLR C
10F4 956C
                SUBB A. VENT_AVG :R1
10F6 40F3
               JC EOI : ?NOT EOI
10F8 C215
10FA D2D3
                SETB PSW.3 :BANK1
10FC C2D4
10FE 7900
                CLR PSW.4
                MOV RCHG_TIM.#OOH :R1
                CHK_EXH:
                             ::FIND AWP PEAK & DROP
1100 E54D
                MOV A.AWP MAX
1102 C3
                CLR C
1103 9540
                SUBB A.AWP_AVG
                1105 4018
                CHK_AWP: ::0
MOV B.A ;SAVE
1107 F5F0
1109 E54D
                MOV A.AWP_MAX
110B C3
                CLR C
110C 9563
110E 4007
                SUBB A.PEEP_AVG : AWP MAX - PEEP
                JC SET_EXH :AWP<PEEP
1110 84
                DIV AB
1111 9405
                SUBB A.#5
1113 4002
                JC SET_EXH :?DRDP 20%
1115 2122
1117 D201
                AJMP DELAYS
                SET_EXH: SETB EXH
             MOV PIP_STORE.AWP_MAX :NEW PIP
1119 854D4E
111C 754000 MOV AWP_MAX.#0 ;RESET
111F 2150
               AJMP CHK_PEAK
1121 00
                NOP
                DELAYS: :: WAIT 0.55
1122 D2D3
                SETB PSW.3 :BANK1
1124 C2D4
                CLR PSW.4
1126 7432
                MOV A, #50
1128 C3
                CLR C
1129 99
                SUBB A,RCHG_TIM
112A 50D4
                JNC CHK_EXH : ?NOT 0.55
112C 00
                NOP
1120 00
               NOP
112E 00
                NOP
               ALARM:
112F 020C
                SETB ALM
               ORL P2.#01110000B :OFF VALVES
1131 43A070
1134 200605
1137 200802
               CHK_SIL: JB SIL.CONT
                JB HOLD.CONT
113A D2A7
               SETB P2.7 : BUZZER ON
1130 DR00
               CONT: SETB WATT
113E D21E
               SETB L16 :WAIT
1140 R52300
               MOV SBUF. LED1
```

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```
ACALL TRANS_DEL
1143 D125
1145 12156E
1148 200CE9
                LCALL SERVICE
                JB ALM.CHK_SIL
1148 752F00
                MOV THREE_CYCLE.#0
114E 01D8
                AJMP MAIN_LOOP
                             ::PRESS LIMIT 120 CM
                CHK_PEAK:
                JB WAIT.CALC_PIP
1150 20000A
                MOV A.PIP_STORE
1153 E54E
1155 C3
                CLR C
                SUBB A.PEEP_AVG
1156 9563
1158 C3
                CLR C
1159 94E0
                 SUBB A. #PIP_THRESH
                JNC HIPRESS
1158 5046
                CALC_PIP:
                RUNNING_AVG PIP_LO.3.PIP_STORE.PIP_AVG
115D
                 :CALCULATES RUNNING AVERAGE OF 3 BYTES IN DATA MEMORY :WITH A LOW ADDRESS OF LODATA. INPUT SIGNAL IS LOCATED
                 :AT INSIG. AVERAGE OUTPUT IS AT AVG.
                PUSH PSW
+115D CODO
                PUSH ACC
+115F C0E0
+1161 COFO
                PUSH B
                 CLR PSW.3 :BANKO
+1163 C2D3
+1165 C2D4
                CLR PSW.4
+1167 7458
                MOV A. #PIP_LO :SET RO
+1169 2403
                 ADD A.#3
                DEC A
+1168 14
+116C F8
                MOV RO,A
                NEXT10001:
+116D 18
                DEC RO
                              :SHIFT UP
                MOV A, GRO
+116E E6
                INC RO
+116F 08
+1170 F6
                 MOV GRO.A
                DEC RO
+1171 18
+1172 8858F8
                 CJNE RO. #PIP_LO.NEXT10001 :LODATA ADDRESS
                 MOV A.PIP_STORE : MOV NEW DATA TO PIP_LO
+1175 ES4E
+1177 75F003
                MOV B.#3
                 DIV AB
+117A 84
                 MOV GRO.A
+1178 F6
+117C 7458
                 MOV A #PIP_LO :ADD TO CALC PIP_AVG
+117E 2403
                 ADD A.#3
                 DEC A
+1180 14
+1181 F51C
                MOV TEMP_STORE,A
+1183 E6
                 MOV A. @RO
                XCH A.RO
+1184 C8
                 NEXT20001:
+1185 CR
                 XCH A.RO
+1186 08
                 INC RO
+1187 26
                 ADD A. @RO
+1188 C8
                 XCH A.RO
+1189 B51CF9
                 CJNE A, TEMP_STORE. NEXT20001
+118C C8
                 XCH A.RO
+118D F55B
                MOV PIP_AVG.A
                POP B
+118F DOFO
+1191 DOEO
                POP ACC
```

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```
POP PSW
+1193 DODO
 1195 00
                  NOP
 1196 00
                  NOP
 1197 00
                  NOP
 1198 200013
                  JB WAIT.STRT_EXH
                  JB HOLD .STRT_EXH
 1198 200810
                  ANL P2.#100011118
                                       :ON VALVES
 119E 53A08F
                  AJMP STRT_EXH
 11A1 21AE
                  HIPRESS:
. LJA3 D22C
                  SETB L34 :HI PRESS
                  MOV SBUF.LED3
 11A5 852599
                  ACALL TRANS_DEL
 11A8 D125
                  NOP
 11AA 00
  11AB 212F
                  ALARM1: AJMP ALARM
 11AD 00
                  NOP
                  STRT_EXH:
                  SETB PSW.3
                                         :BANKI ...
  11AE D2D3
                  CLR PSW.4
  11B0 C2D4
                                         :R1.RST CHARGE TIME
  1182 7900
                  MOV RCHG_TIM, #OOH
                  CHARGE:
 1184 C2D3
                  CLR PSW.3
                                           :BANK O
                  LCALL SERVICE
  1186 12156E
  1189 200CEF
                  JB ALM.ALARMI
                                     : VENTILATOR INSPIRATION?
 118C E518
                  MOV A. VENT_HI
                  CLR C
  11BE C3
  118F 956C
11C1 5023
                  SUBB A. VENT_AVG
                                       :?NO VENT INSP1
                  JNC CHK_CHGTIM
  11C3 43A070
                  ORL P2.#01110000B : OFF VALVES
                  CHK_VOL: SETB PSW.3 :BANK1
CLR PSW.4
  11C6 D2D3 .
  11C8 C2D4
                  JB WAIT, CHK_WAIT1
  11CA 200016
  11CD E519
                  MOV A.SET_CHGTIM
  11CF C3
                  CLR C
                  SUBB A.RCHG_TIM :R1
  1100 99
                  JC CHK_WAIT1 :: VOL>SET
  1101 4010
  11D3 F5F0
                  MOV B.A
  1105 E519
                  MOV A, SET_CHGTIM .
  11D7 84
                  DIV AB
  11D8 940A
                  SUBB A. #10
                  JNC CHK_WAIT1
SETB L17 :LO FLOW LED
  11DA 5007
  11DC D21F
11DE 852399
                  MOV SBUF, LED1
                  ACALL TRANS DEL
  11E1 D125
                   CHK_WAIT1: AJMP CHK_WAIT
  11E3 6108
  11E5 00
                  NUS
                  CHK_CHGTIM: MOV A.SET_CHGTIM :SET VOLUME REACHED?
  11E6 E519
                  SETB PSW.3
  11EB D2D3
                                       :BANKI
  TIEA C3
                  CLR C
  11EB 99
                  SUBB A.RCHG_TIM :R1
JNC CHARGE :?VOL < SET VOL
ORL P2.#01110000B :OFF
  11FC 5006
                                          :OFF VALVES
  11EE 43A070
```

```
JB WAIT.CHK_EDEXH1
11F1 20004B
               JBC CLOGI.FIRST_SAMP : MEAS FLT LD SAMP
11F4 101629
11F7 30172B
               JNB CLOG2.FLT_LD
               CLR CLOG2 :SECOND SAMPLE
11FA C217
               MOV A.FLTFLO_AVG
11FC E544
11FE 2545
               ADD A.CLOG_LO
1200 F546
               MOV CLOG_HI, A : UPPER LIM FILT CLOG
1202 C3
               CLR C
               RRC A
                      :DIV BY 2
1203 13
1204 F545
               MOV CLOG_LO.A : LOWER LIM FILT CLOG
               CLR C
1206 C3
                      HALF CLOG LO
1207 13
               RRC A
1208 F5F0
               MOV B.A :SAVE
               ADD A.CLOG_LO
120A 2545
120C F556
               MOV FLTLD50.A :STORE 50% LEVEL
120E E5F0
               MOV A.B
1210 C3
               CLR C
               RRC A : ONE FOURTH CLOG LO
1211 13
1212 F5F0
               MOV B.A :SAVE
               ADD A.CLOG_LO
1214 2545
               MOV FLTLD25.A
                              :STORE 25% LEVEL
1216 F555
1218 ESFO
               MOV A.B
121A 2556
               ADD A.FLTLD50
               MOV FLTLD75.A :STORE 75% LEVEL
121C F557
121E 4142
               AJMP CHK_DPTHRESH
                             ::FIRST FLT LD SAMP
               FIRST_SAMP:
               MOV CLOG_LO.FLTFLO_AVG :SAVE
1220 854445
               AJMP CHK_DPTHRESH
1223 4142.
               FLT_LD: ::SAVE FILT LOAD %
               MOV A. FLTFLO_AVG
1225 E544
1227 C3
               CLR C
1228 9546
               SUBB A.CLOG_HI
122A 402F
               JC TEST75
122C D236
               SETB L26 :FILTER CLOG LED
122E 852399
               MOV SBUF, LED1
1231 D125
               ACALL TRANS_DEL .
1233 752C10
               MOV FLTLD_HUN.#10H
                                    :SET FILTER LOAD 100%
1236 752001
               MOV FLTLD_TEN.#01H
1239 752E02
               MOV FLTLD_ONE.#02H
123C 212F
               AJMP ALARM
123E 00
123F 41A7
               CHK_EDEXH1: AJMP CHK_EDEXH
1241 00
               NOP
               CHK_DPTHRESH:
1242 E544
               MOV A. FLTFLO_AVG
1244 C3
               CLR C
1245 9480
               SUBB A. #FILTDP_THRESH
1247 40F6
               JC CHK_EUEXH1 ; BELOW THRESH
1249 0236
               SETB L26 :FILT CLOG LED
124B 852699
               MOV SBUF.LED2
```

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```
ACALL TRANS_DEL
124E 0125
                MOV FLTLD_HUN.#10H
1250 752C10
1253 752001
1256 752E02
                MOV FLTLD_TEN.#01H
MOV FLTLD_ONE.#02H
1259 212F
                AJMP ALARM
                TEST75: ::TEST 75% CLOG
                MOV A.FLTFLO AVG
1258 E544
125D C3
                CLR C
125E 9557
                SUBB A.FLTLD75
1260 4012
                JC TESTSO
                SETB L15
                             :FILTER CHANGE LED
1262 0210
1264 852399
                MOV SBUF. LED1
1267 0125
                ACALL TRANS_DEL
1269 752CF0
                MOV FLTLD_HUN. #OFOH
                MOV FLTLD_TEN.#71H
MOV FLTLD_ONE.#52H
126C 752D71
126F 752E52
1272 4142
                AJMP CHK_OPTHRESH
                TESTSO: :: TEST 50% CLOG
1274 E544
                MOV A.FLTFLO_AVG
                CLR C
1276 CJ
1277 9556
                SUBB A.FLTLD50
1279 4008
                JC TEST25
                MOV FLTLD_HUN. #OFOH MOV FLTLD_TEN. #51H
1278 752CFO
127E 752051
1281 752E02
                MOV FLTLD_ONE.#02H
                AJMP CHK_DPTHRESH
1284 4142
                 TEST25: ::TEST 25% CLOG
                MOV A.FLTFLO_AVG
1286 E544
                CLR C
1288 C3
1289 9555
                SUBB A, FLTLD25
1288 4008
                JC TESTO
1280 752CF0
                MOV FLTLD_HUN.#OFOH
                MOV FLTLD_TEN.#21H
MOV FLTLD_ONE.#52H
1290 752D21
1293 752E52
1296 4142
                AJMP CHK_DPTHRESH
                 TESTO:
1298 752CF0
                MOV FLTLD_HUN. #OFOH
1298 752DF1
                MOV FLTLD_TEN.#OFIH
129E 752E02
                MOV FLTLD_ONE.#Q2H
12A1 4142
                AJMP CHK_DPTHRESH
12A3 00
                NOP
12A4 212F
                ALARM2: AJMP ALARM
12A6 00
                HOP
                 CHK_EOEXH:
                LCALL SERVICE
12A7 12156E
1288 200CF7
                 JB ALM.ALARM2
12AD C2D3
                CLR PSW.3 :BANKO
12AF C2D4
                CLR PSW.4
1281 E518
                MOV A, VENT_HI
                 SUBB A. VENT_AVG :R1
12B3 956C
1285 503F
                JNC PAT_INSP
CLR EXH : END
1287 C201
                          : END OF EXHALATION
: 283
                RUNNING_AVG PEEP_LO.3.AWP_AVG.PEEP_AVG
```

```
:CALCULATES RUNNING AVERAGE OF 3 BYTES IN DATA MEMORY
                 :WITH A LOW ADDRESS OF LODATA. INPUT SIGNAL IS LOCATED
                 :AT INSIG. AVERAGE OUTPUT IS AT AVG.
                 PUSH PSW
+1289 CODO
                 PUSH ACC
+1288 COEO
+1280 COFO
                 PUSH B
+128F C2D3
                 CLR PSW.3
                             :BANKO
+12C1 C2D4
+12C3 7460
                 CLR PSW.4
                 MOV A. #PEEP_LO
                                  :SET RO
+1205 2403
                 ADD A.#3
+1207 14
                 DEC A
+12C8 F8
                 MOV RO.A
                 NEXT10002:
                 DEC RO
+12C7 18
                               :SHIFT UP
+12CA E6
                 MOV A. GRO
                 INC RO
+12CB 08
                 MOV GRO.A
+1200 F6
+12CD 18
+12CE 8860FB
                 DEC RO
                 CJNE RO. #PEEP_LO.NEXT10002 :LODATA ADDRESS
+1201 E54C
+1203 75F003
+1206 84
                                   :MOV NEW DATA TO PEEP_LO
                 MOV A.AWP_AVG
                 MOV 8.#3
                 DIV AB
+1207 F6
                 MOV GRO.A
                 MOV A. *PEEP_LO : ADD TO CALC PEEP_AVG
+12D8 7460
+12DA 2403
                 ADD A.#3
+12DC 14
                 DEC A
                 MOV TEMP_STORE.A
+1200 F51C
+12DF E6
+12E0 C8
                 MOV A, ORO
                 XCH A.RO
                 NEXT20002:
+12E1 C8
                 XCH A.RO
INC RO
+12E2 08
+12E3 26
                 ADD A. GRO
                 XCH A.RO
+12E4 C8
+12E5 B51CF9
                 CJNE A.TEMP_STORE.NEXT20002
                 XCH A.RO
+12E8 C8
+12E9 F563
                 MOV PEEP_AVG.A
                 POP B
+12EB DOFO
                 POP ACC
+12ED DOE0
+12EF DODO
                 POP PSW -
                 NOP
 12F1 00
 12F2 00
                 NOP
 12F3 00
                 NOP
 12F4 610B
                  AJMP CHK_WAIT
                 PAT_INSP:
 12F6 E563
                  MOV A.PEEP_AVG
 12F8 C3
12F9 954C
                  CLR C
                  SUBB A.AWP_AVG : PEEP - AWP
                  JC CHK_EDEXH
                                   :AWP > PEEP
 12FB 40AA
 12FD 9408
                  SUBB A. #PATINSP THRESH
 12FF 40A6
                  JC CHK_EDEXH
                                 : ?NO PAT INSP
 1301 C201
                  CLR EXH
 1303 0207
                  SETB SPON_BR
```

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```
NOP
1305 00
1306 00
                NOP
                NOP
1307 00
                CHK_WAIT: :: CHECK 3 CYC WAIT JNB WAIT.GO_ON
1308 300025
                JB VEN_SEL.GO_ON
1308 200429
130E 200328
                JB VOL_CHG.GO_ON
1311 200825
1314 7402
                 JB HOLD.GD_ON
                MOV A.#2
1316 C3
1317 952F
                CLR C
                 SUBB A. THREE_CYCLE
                 JNC INC3
1319 5018
                CLR WAIT
1318 C200
                 CLR L16
1310 C21E
                 SETB CLOGI
131F 0216
                 SETB CLOG2
1321 0217
                 MOV SBUF . LED1
1323 852399
                 ACALL TRANS_DEL
1326 0125
                MOV RON_TIM.#0 :RESET AFTER WAIT MOV ROFF_TIM.#0
1328 7000
132A 7D00
132C 755000
                 MOV POSSUM. #0
                 MOV NEGSUM. #0
132F 755100
                 AJMP GO_ON
1332 6139
                 NOP
1334 00
                 NOP
1335 00
                 INC3:
                 INC THREE_CYCLE
1336 052F
                 NOP
1338 00
                 GO_ON: ::START MAIN LOOP
                 AJMP MAIN_LOOP
1339 01D8
1338 00
                 NOP
                 OUTI: AJMP DUT
133C 61EB
                 NOP
 133E 00
                 BLINK_BEEP: :: ON/OFF DISPLAY & BUZZER
                 JBC DIV23.OUT1 :PERIOD 0.45
 133F 1038FA
 1342 D238
                 SETB DIV23
                 JB_ALM_TST.OUT1
 1344 200AF5
 1347 C2D3
                 CLR PSW.3
                              :BANKO
                 CLR PSW.4
 1349 C2D4
                 JBC OFF_ALM.TURN_OFF
 1348 100050
                 TURN_ON: ::DISPLAY/ALM ON SETB OFF_ALM
 134E D20D
                 JNB L17.CHK_LED21
 1350 301F05
                                  RESTORE LED'S
                 MOV SBUF, LEDI
 1353 852399
 1356 0125
                  ACALL TRANS_DEL
                 CHK_LED21:
                  MOV A. LEDZ
 1358 E526
                 ANL A. BOFOH
 135A 54F0
 135C 6005
                  JZ CHK_LED31
                 MOV SBUF LED2
                  ACALL TRANS DEL
 1361 0125
```

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```
CHK_LED31:
                MOV A.LED3
1363 E525
                ANL A. #OFOH
1365 54F0
1367 6005
                JZ CHK VOLI
1369 852599
                MOV SBUF.LED3
                ACALL TRANS_DEL
136C D125
                CHK VOL1: JNB VOL_CHG.TST_VENTSEL1 MOV SBUF.CHG_VOL : SET HUNS
136E 30030F
1371 852899
                ACALL TRANS_DEL
1374 D125
                                  :SET TENS TO O
1376 759901
                MOV SBUF. #01H
                ACALL TRANS_DEL
1379 D125
                                 :SET ONES TO O
1378 759902
                MOV SBUF. #02H
                ACALL TRANS_DEL
137E D125
                TST_VENTSEL1:
                JNB VEN_SEL.TST_TEMP1
1380 300404
                MOV SBUF . RVENT
1383 8E99
                ACALL TRANS_DEL
1385 D125
                 TST_TEMP1:
                JNB TEMP. TST_BEEP1
1387 303B0A
138A 851299
                MOV SBUF. TEMP_DEC : TENS
                ACALL TRANS_DEL
138D 0125
                MOV SBUF. #02H : ONES
138F 759902
                 ACALL TRANS_DEL
1392 0125
                 TST_BEEP1:
                JNB BEEP. OUT
1394 301454
1397 200651
                 JB SIL.OUT
                             BUZZER ON
                 SETB P2.7
139A D2A7
                 AJMP OUT
139C 61EB
                 TURN_OFF:
                             ::DISPLAY/ALM OFF
                 JNB L17.CHK_LED22
139E 301F08
13A1 E523
                 MOV A.LEDI
                              :MASK LED'S
13A3 547F
                 ANL A.#7FH
13A5 F599
                 MOV SBUF.A
                 ACALL TRANS_DEL
13A7 D125
                 CHK_LED22:
13A9 E526
                 MOV A.LED2
                 ANL A. #OFOH
13AB 54F0
13AD 6005
13AF 759905
                 JZ CHK_LED32
                 MOV SBUF, #05H
 1382 D125
                 ACALL TRANS_DEL
                 CHK_LED32:
 1384 E525
                 MOV A.LED3
                 ANL A. #OFOH
 1386 54F0
                 JZ CHK_VOLZ
 13B8 60C5
                 MOV SBUF . #06H
 13BA 759906
 13BD D125
                 ACALL TRANS_DEL
                 CHK_VOL2: JNB VOL_CHG.TST_VENTSEL2
 13BF 30030F
 13C2 7599F0
                                   : OFF HUNS
                 MOV SBUF . #OFOH
 13C5 D125
                 ACALL TRANS_DEL
 1307 7599F1
                 MOV SBUF. #OF1H
                                   : OFF TENS
 13CA 0125
                 ACALL TRANS_DEL
                                   : OFF ONES
                 MOV SBUF. #OF2H
 1300 7599F2
 13CF D125
                 ACALL TRANS_DEL
                 TST_VENTSEL2:
 13DL 300405
                 JNB VEN SEL . TST TEMP2
```

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```
: VENT SEL OFF
               MOV SBUF. #OF3H
13D4 7597F3
               ACALL TRANS_DEL
1307 0125
               TST_TEMP2:
               JNB TEMP.TST_BEEP2
13D9 303B0A
               MOV SRUF . # OFT TENS
13DC 7599F1
               ACALL TRANS_DEL
13DF 0125
               MOV SBUF. #OF2H : OFF ONES
13E1 7599F2
               ACALL TRANS_DEL
13E4 D125
               TST_BEEP2:
JNB BEEP.OUT
13E6 301402
               CLR P2.7 :AUDIO OFF
13E9 C2A7
               OUT:
               MOV THO. #70H :RST TIMERO
13EB 758070
13EE D2A9
               SETB ETO
               SETB TRO
13F0 D28C
               RET
13F2 22
          L
                             ::TIMER O INTERRUPT
               TIM_SAMP:
                           :SAVE SFR'S
               PUSH ACC
13F3 COE0
               PUSH B
13F5 COFO
               PUSH PSW
13F7 CODO
               MOV THO. #70H ; RESET TIMER
13F9 758C70
               SETB PSW.3 : SELECT REGISTER BANK 1
13FC D2D3
               CLR PSW.4
13FE C2D4
1400 100204
1403 D202
               JBC DIV21,CLEAR
               SETB DIV21 ; FREQ 100HZ
                AJMP RETURN
1405 A167
               CLEAR: INC RCHG_TIM ;R1
1407 09
                DJNZ RDIV10, SAMPLE :R2
1408 DA28
               MOV RDIV10.#10 :RESET RDIV10
140A 7A0A
140C 100B04
                JBC DIV22.SET_CLK
140F D20B
                SETB DIV22
                AJMP SAMPLE
1411 8135
                SET_CLK: ::SET .25 CLOCK
                SETB CLK
1413 0239
1415 100E02
                JBC DIV24, CONT6
1418 DZOE
                SETB DIV24
                CONT6: DJNZ RDIV5.SAMPLE
                                          :R3
141A DB19
                MOV RDIV5.#5 :FRED 1 HZ
141C 7B05
                :SILENCE 2 MIN
                JNB SIL.CHK_HOLD
141E 300608
                                     :BUZZER OFF
                CLR P2.7
1421 C2A7
                DJNZ RSIL_TIM.CHK_HOLD : : NOT 2 MIN
1423 DE04
                MOV RSIL_TIM.#120 :R6. RESET 2 MIN
1425 7E78
1427 0206
                CLR SIL
                CHK HOLD: ::STOP NEB?
                JNB HOLD SAMPLE
1429 300809
                DJNZ RHOLD_TIM.SAMPLE :R7
1420 DF07
                MOV RHOLD TIM. #120
142E 7F78
 1430 200602
                JB SIL.SAMPLE
                SETB P2.7 :ON BUZZER
 1433 D2A7
```

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```
SAMPLE: :: READ VENT SIG
CLR PSW.3 : BANK O
1435 0203
                 CLR PSW.4
1437 C2D4
                                     :CLEAR MUX ADDRESS
                 ANL PZ.#11111000B
1439 53AOF8
143C 02A3
                 SETB P2.3
                 ANALOG RVENT_SIG NOP :DELAY TIME FOR MUX
143E
+143E 00
+143F 00
                 NOP
+1440 00
                 NOP
+1441 00
                 HOP
                 NOP
+1442 00
                 CLR P2.3 :START CONVERSION
+1443 C2A3
                        :ALLOW CONV. TIME 5 MICROSEC
+1445 00
                 NOP
                 NOP
+1446 00
+1447 00
                  NOP
                  MOV RVENT_SIG.P1 :SAVE DIGITAL OUTPUT
+1448 A990
                  SETB P2.3
+144A D2AJ
144C 00
                  NOP
                  RUNNING_AVG VENT_LOW, 4. RVENT_SIG. VENT_AVG
 1440
                  :CALCULATES RUNNING AVERAGE OF 4 BYTES IN DATA MEMORY :WITH A LOW ADDRESS OF LODATA. INPUT SIGNAL IS LOCATED
                  :AT INSIG. AVERAGE OUTPUT IS AT AVG.
+144D C0D0
+144F C0E0
                  PUSH PSW
                  PUSH ACC
+1451 COFO
                  PUSH 8
                  CLR PSW.3 :BANKO
+1453 C2D3
+1455 C2D4
+1457 7468
                  CLR PSW.4
                  MOV A. MVENT_LOW :SET RO
                  ADD A.#4
+1459 2404
+1458 14
+145C F8
                  DEC A
                  MOV RO.A
                  NEXT10004:
+145D 18
                  DEC RO
                 MOV A. ORO
                               :SHIFT UP
+145E E6
                 INC RO
+145F 08
                  MOV GRO.A
+1460 F5
                 DEC RO
+1461 18
                 CJNE RO. #VENT_LOW. NEXT10004 :LODATA ADDRESS
+1462 8868F9
                 MOV A . RVENT SIG : MOV NEW DATA TO VENT_LOW
+1465 E9
+1466 75F004
                  MOV B . 44
+1469 84
                  DIV A8
                  MOV GRO.A
+146A F6
                  MOV A. #VENT_LOW : ADD TO CALC VENT_AVG
+146B 746B
+146D 2404
                  ADD A. 84
 +146F 14
                  DEC A
                  MOV TEMP_STORE,A
+1470 F51C
                  MOV A. GRO
+1472 E6
+1473 C8
                  XCH A.RO
                  NEXT20004:
+1474 CB
                  XCH A.RO
                  INC RO
+1475 08
                  ADD A.GRO
+1476 26
+1477 CS
                  XCH A.RO
                  CJNE A. TEMP_STORE.NEXT20004
 +1478 851CF9
```

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```
XCH A.RO
+1478 C8
                MOV VENT_AVG.A
+147C F56C
+147E DOFO
                 POP 8
                 POP ACC
+1480 DOE0
                 POP PSW
+1482 DODO
                 NOP
 1484 00
                 INC PZ
 1485 05A0
                 ANALOG RELT_FLD
1487
                 NOP : DELAY TIME FOR MUX
+1487 00
                 NOP
+1488 00
                 NOP
+1489 00
                 NOP
+148A 00
                 NOP
+1488 00
                 CLR P2.3 :START CONVERSION
+148C C2A3
                        :ALLOW CONV. TIME 5 MICROSEC
                 NOP
+148E 00
                 NOP
+148F 00
                  NOP
+1490 00
                                      SAVE DIGITAL OUTPUT
                 MOV RELT_FLO.P1
SETB P2.3
+1491 AA90
+1493 DZA3
                  NOP
 1495 00
                  RUNNING_AVG FLTFLO_LO.4.RFLT_FLO.FLTFLO_AVG
                  :CALCULATES RUNNING AVERAGE OF 4 BYTES IN DATA MEMORY :WITH A LOW ADDRESS OF LODATA. INPUT SIGNAL IS LOCATED :AT INSIG. AVERAGE OUTPUT IS AT AVG.
 1496
                  PUSH PSW
+1496 CODO
                  PUSH ACC
+1498 COEO
                  PUSH B
 +149A COFO
                 CLR PSW.3 ;BANKO
 +149C C2D3
                  CLR PSW.4
 +149E C2D4
                 MOV A. #FLTFLO_LO :SET RO
 +1440 7440
 +14A2 2404
                  ADD A.#4
                  DEC A
 +1404 14
                  MOV RO.A
 +14A5 F8
                  NEXT10006:
                  DEC RO
 +1486 18
                               :SHIFT UP
                  MOV A. GRO
 +14A7 Eó
                  INC RO
 +1448.08
                  MOV GRO.A
 +14A9 F6
                  DEC RO
 +14AA 18
                  CJNE RO #FLTFLO_LO .NEXT10006 ; LODATA ADDRESS
 +14A8 8840F8
                  MOV A.RELT_FLO : MOV NEW DATA TO FLTFLO_LO
 +14AE EA
                  MOV B.#4
 +14AF 75F004
                  DIV AB
 +1482 84
                  MOV GRO.A
 +14B3 F6
                  MOV A. #FLTFLO_LO :ADD TO CALC FLTFLO_AVG
 +1484 7440
                   ADD A.#4
 +1486 2404
                   DEC A
 +1488 14
                   MOV TEMP_STORE.A
 +1489 F51C
                   MOV A. GRO
  +1488 E6
                   XCH A.RO
  +148C CS
                   NEXT20006:
                   XCH A.RO
  +148D C8
                  INC RO
  +148E 08
                   ADD A. GRO
  +148F 25
                   XCH 4.RO
  +14C0 C8
```

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```
CJNE A. TEMP_STORE.NEXT20006
+14C1 851CF9
+14C4 C8
                 XCH A.RO
                 MOV FLTFLO_AVG.A
-14C5 =544
                  POP B
+14C7 DOFO
                  POP ACC
+14C7 DOEO
                  POP PSW
+14C8 DODO
                  HOP
 14CD 00
                 INC PZ
 14CE 05A0
                  ANALOG RAW_PRESS
NOP :DELAY TIME FOR MUX
 1400
+14D0 00
                  NOP
+14D1 00
+1102 00
                  NOP
                  NOP
+1403 00
                  NOP
+14D4 00
                  CLR P2.3 :START CONVERSION
+14D5 C2A3
                          :ALLOW CONV. TIME 5 MICROSEC
+1407 00
                  NOP
                  NOP
+1408 00
                  HOP
+14D9 00
                                         :SAVE DIGITAL DUTPUT
                  MOV RAW_PRESS.P1
+14DA A890
                  SETB P2.3
 +14DC D2A3
                  NOP
 14DE 00
                  RUNNING_AVG AWP_LO,4,RAW_PRESS,AWP_AVG
                  :CALCULATES RUNNING AVERAGE OF 4 BYTES IN DATA MEMORY :WITH A LOW ADDRESS OF LODATA. INPUT SIGNAL IS LOCATED
 140F
                  :AT INSIG. AVERAGE OUTPUT IS AT AVG.
                  PUSH PSW
 +140F C000
                  PUSH ACC
 +14E1 COEO
 +14E3 COFO
+14E5 C2D3
                  PUSH B
                  CLR PSW.3 :BANKO
                  CLR PSW.4
 +14E7 C2D4
                  MOV A. #AMP_LO :SET RO
 +1459 7448
                  ADD A.#4
 +14EB 2404
 +14ED 14
                  DEC A
                  MOV RO.A
 +14EE FB
                  NEXT1000B:
                  DEC RO
 +14EF 18
                                 :SHIFT UP
                   MOV A. ORO
 +14F0 E6
                   INC RO
 +14F1 08
                   MOV GRO.A
 +14F2 F6
                   DEC RO
 +14F3 18
                   CJNE RO, #AMP_LO.NEXT10008 :LODATA ADDRESS
 +14F4 8848F8
                                       :MOV NEW DATA TO AMP_LO
 +14F7 EB
                   MOV A.RAW_PRESS
                   MOV 8.84
 +14F9 75F004
 +14FB 84
                   DIV AB
                   MOV GRO.A
 +14FC F6
                   MOV A. #AWP LO :ADD TO CALC AWP_AVG
 +14FD 7448
+14FF 2404
                   ADD A.#4
  +1501 14
                   DEC A
                   MOV TEMP_STORE.A
 +1502 F51C
                   MOV A. GRO
  -1504 E5
                   XCH A.RO
 +1505 CB
                   NEXT20008:
 +1506 C8
+1507 08
                   XCH A.RO
                   INC RO
  +1508 25
                   ADD A. GRO
```

```
XCH A.RO
+1509 C8
                CJNE A.TEMP_STORE.NEXT20008
+150A 851CF9
                XCH A.RO
+150D C8
                MOV AWP_AVG.A
+150E F54C
+1510 DOFO
                POP 8
                POP ACC
+1512 DOEO
                POP PSW
+1514 0000
 1516 00
1517 30150A
                NOP
                JNB THSP NEXT SAMP
                MOV A.AWP_MAX
 151A E54D
                CLR C
 151C C3
                 SUBB A.AWP_AVG
 151D 954C
 151F 5003
1521 854C4D
                 JNC NEXT_SAMP
                 MOV AWP_MAX.AWP_AVG
                 NEXT_SAMP:
                 NOP
 1524 00
 1525 05A0
                 INC PZ
                 ANALOG RNEB_FLO
 1527
                 NOP :DELAY TIME FOR MUX
+1527 00
                 NOP
+1528 00
                 NOP
+1529 00
                 NOP
+152A 00
                 NOP
+1528 00
                              :START CONVERSION
                 CLR P2.3
+152C C2A3
                        ;ALLOW CONV. TIME 5 MICROSEC
+152E 00
                 NOP
                 NOP
+152F 00
                 NOP
 +1530 00
                                     SAVE DIGITAL OUTPUT
                 MOV RNEB_FLO.P1
+1531 AC90
                 SETB P2.3
 +1533 D2A3
                 NOP
  1535 00
                 MOV A.RNEB_FLO :R4
  1536 EC -
                 CLR C
  1537 C3
  1538 9432
                 SUBB A, #50
                 JC NEGFLO
  153A 400E
                 CLR C :DIV BY 4
  153C C3
  1530 13
                 RRC A
                 CLR C
  153E C3
                 RRC A
  153F 13
                 ADD A POSSUM SUN POS FLOW
  1540 2550
                 MOV POSSUM.A :SAVE
  1542 F350
                  JNC CONTI
  1544 500F
                  SETB FLOW : OVERFLOW CONDITION
  1546 D20F
                  SJMP CONT1
  1548 8008
                  NEGFLO: :: NEG FLOW
                  MOV A, #50
  154A 7432
                  SUBB A.RNEB_FLO
  154C 9C
                  CLR C :DIV BY 4
  1540 CJ
                  RRC A
  154E 13
  154F C3
                  CLR C
                  RRC A
  1550 13
1551 2551
                  ADD A . NEGSUM
                  MOV NEGSUM.A :SAVE
   1553 F551
                  CONT1:
                  NOP
   1555 00
   1556 0540
                  INC PZ
```

```
ANALOG RTEMP
1558
                 NOP : DELAY TIME FOR MUX
+1558 00
+1559 00
                 NOP
                 NOP
+155A 00
                 NOP
-1558 00
                 NOP
+155C 00
                               :START CONVERSION
                 CLR P2.3
+155D C2A3
                       :ALLOW CONV. TIME 5 MICROSEC
+155F 00
                 NOP
                 NOP
+1560 00
                 NOP
+1561 00
                                   :SAVE DIGITAL OUTPUT
                 MOV RTEMP.P1
+1562 AD90
                 SETB P2.3
+1564 D2A3
                 NOP
 1566 00
                          ::RET FROM INT
                 RETURN:
                 POP PSW
 1567 DODO
                 POP B
 1569 DOFO
                 POP ACC
 1568 DOEO
 156D 32
                 RETI
                 SERVICE: ;: CHK FLOW, SER-REC. BLINK
                 JBC CLK.TEMP_CONT
 156E 103902
 1571 22
                 RET
 1572 00
                 NOP
                 TEMP_CONT: ;:CONTROL HEATER CLR PSW.3 :BANKO
 1573 C2D3
 1575 C2D4
                 CLR PSW.4
 1577 ED
                 MOV A.RTEMP :RS
 1578 84A00C
                 CJNE A, #TEMP_HI, NOT_ED
                 HITEMP: :: OVER BOC
CLR PO.1 : HEAT OFF
 1578 C281 _
                 CLR HEAT
 1570 C23A
 157F D220
                 SETB L35 :HI TEMP LED
                 MOV SBUF.LED3
 1581 852599
                 SETB ALM
 1584 D20C
                 RET
 1586 22
                 NOT_EQ: JNC HI_TEMP ;RTEMP>TEMP_HI
 1587 5022
 1589 E511
                 MOV A. TEMP_SET
                 CJNE A: #40 HEAT CHK
 1588 842804
                 CLR PO.1 :HEAT DFF
 1.58E C281
                 AJMP FLO_TST
 1590 A185
                 HEAT_CHK: :: CHK HEAT BIT
                 JB HEAT . SW_OFF
 1592 203A0C
                 CLR C
 1595 C3
                  SUBB A.#10 ; LOW LIMIT
 1596 940A
                  SUBB A.RTEMP :RS
 1598 9D
                 JC FLO_TST : ?LEAVE OFF? SETB PO.1 : TURN ON
 1599 401A
 1598 D281
 1590 023A
                 SETB HEAT
 159F A185
                  AJMP FLO_TST
                  SW_OFF:
                 ADD A.#10 :UPPER LIMIT
 15A1 240A
 15A3 C3
                 CLR C
                  SUBB A.RTEMP
 1564 9D
                 JNC FLO TST : ?LEAVE ON?
 15A5 500E
```

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```
:TURN OFF
               CLR PO.1
15A7 C281
               CLR HEAT
15A9 C23A
               HI_TEMP:
                          :: TEMP ALARM
               SETB L35 :HI TEMP LED
15AB 0220
               MOV SBUF, LED3
15A0 852539
               ACALL TRANS_DEL
1580 D125
               SETB ALM
1582 D20C
               RET
1584 22
               FLO_TST: :: TEST NEB FLOW
               JB WAIT.CHK_SERPORT
1585 200070
               SETB PSW.3 ; BANKI
1588 D2D3
               CLR PSW.4
158A C2D4
15BC 100F1C
               JBC FLOW.FLO
               MOV A.POSSUM
158F E550
15C1 C3
               CLR C
               SUBB A.NEGSUM : CALC SFLO
1502 9551
               JNC CONT2
15C4 5004
               DJNZ ROFF_TIM.CONT4
15C6 DD17
               AJMP NOFLO_ALM
15C8 A1F7
               CONT2:
               MOV B.A :SAVE SFLO=POS-NEG
15CA FSFO
               SUBB A. #NOFLO_TH :SFLO-THRESH
15CC 948C
                JNC CONT3
15CE 5004
               NOFLO: DJNZ ROFF_TIM, CONT3
15D0 DD02
               AJMP NOFLO_ALM
15D2 A1F7
                CONT3:
                        :SFLO
               MOV A.B
15D4 ESFO
               CLR C
15D6 C3
                SUBB A. #FLO_TH ; SFLO-THRESH JC CONT4 ; ? SFLO<THRESH
1507 942D
1509 4004
               FLO: DJNZ RON_TIM.CONT4
15DB DC02
                AJMP FLO_ALM
1500 CIGE
                CONT4: :: CHECK TIME
                MOV POSSUM. #0 : RESET FLOW SUM
15DF 755000
               MOV NEGSUM. #0
15E2 755100
                DJNZ ONTIMER.CHK_OFFTIM
15E5 D51405
                MOV ONTIMER. #FLOTIM
15EB 75140B
                MOV RON_TIM. #FLOTIM
15EB 7C0B
                CHK_OFFTIM:
                DJNZ OFFTIMER.CHK_SERPORT
15ED D51538
                MOV OFFTIMER, #NOFLOTIM
15F0 751532
                MOV ROFF_TIM. #NOFLOTIM
15F3 7D32
                AJMP CHK_SERPORT
15F5 C128
                NOFLO_ALM: :?NEB OFF > 105
15F7 755000
                MOV POSSUM. #0
15FA 755100
                MOV NEGSUM. #0
                MOV OFFTIMER. #NOFLOTIM
15FD 751532
                MOV ROFF_TIM. #NOFLOTIM
1600 7032
                SETB BEEP
1602 0214
                SETB ALM
1604 D20C
                           :NO FLOW LED
                SETB LZ4
1606 0234
               MOV SBUF.LED2
1608 852679
                ACALL TRANS_DEL
 160B 0125
                RET
160D 22
```

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```
FLO_ALM: ::NEB ON > 2.25
160E 755000
               MOV POSSUM. #0
1611 755100
1614 75140B
               MOV NEGSUM. #0
               MOV ONTIMER. #FLOTIM
1617 7008
               MOV RON_TIM. #FLOTIM
               SETB ALM :FLAG
1619 0200
               SETB L27 : CONT FLOW ALM
161B 0737
1610 352679
               MOV SBUF . LED2
1620 01.25
               ACALL TRANS_DEL
1.622 22
               RET
1623 613F
               BLINK_BEEP1: AJMP BLINK_BEEP
               TRANS_DEL: :: DELAY 2.25MS.CC=80EH
               LJMP TRANS_DEL L
1625 0219BE
               CHK_SERPORT: :: NEW CHAR REC?
               JNB RI.BLINK_BEEPI
1628 3098FB
               CLR RI
162B C298
1620 C2A3
                         ;DISABLE TIMER O INT
               CLR ETO
               CLR TRO :DISABLE TIMER O
162F C28C
1631 E599
               MOV A.SBUF : READ CODE RECEIVED
               SWAP A
1633 C4
                       :MULTIPLY BY 2
1634 23
               RL A
1635 901639
               MOV DPTR. #JUMP_TBLE1
1638 73
               JMP @A+DPTR
1639 C17D
               JUMP TBLE1: AJMP CASEO
                                        TEMP. SET
163B C1F4
                            AJMP CASE1
                                        :NEB. HOLD
                                        SELF TEST
                            AJMP CASE2
163D E19F
163F E19D
                            AJMP CASE3 :NO ACTION
AJMP CASE4 :VENT SEL
1641 E126
1643 E1AT
                            AJMP CASE5 : DISPLAY TEMP
                            AJMP CASE61 :ALM SIL
1645 0150
                            AJMP CASE71 :NO ACTION
1647 C161
                                          :CHANGE VOL
1649 E169
                            AJMP CASES
1648 0165
                            AJMP CASE91
                                         ;DISPLAY FILT LD
1640 0169
                            AJMP CASEAL :ALM RESET
164F C16D
                            AJMP CASEBL : NO ACTION
                         AJMP CASECI
AJMP CASEDI
                                         :ENTER
:DISPLAY PIP
1651 CI71
1653 C175
                            AJMP CASEEL :ALM TEST
1655 C179
1657 C15A
                            AJMP CASEF
                                         :NO ACTION
1659 00
               NOP
               CASEF: : NO ACTION
165A 613F
               AJMP BLINK_BEEP
1650 00
               NOP
1650 021860
               CASE61: LJMP CASE6
1660 00
               NOP
               CASE71: LJMP CASE7
1661 021867
1664 00
               NOP
1665 021818
               CASEP1: LJMP CASEP
1668 00
               NOP
1669 021874
               CASEAL: LJMP CASEA
1660 00
               NOP
166D 02186A
               CASEB1: LIMP CASEB
```

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```
NOP
1,570 00
                CASEC1: LJMP CASEC
1671 021843
                NOP
1674 00
                CASEDI: LJMP CASED
1675 0218D7
                NOP
1678 00
                CASEEL: LJMP CASEE
1679 021955
1670 00
                NOP
                CASEO: ::TEMP SET JB TEMP, NEW_TEMP
1670 203819
                 SETB TEMP
1680 0238
                 MOV A. TEMP_SET
1682 E511
                CJNE A.#40.DISPLAY_TEMP
OFF_STATE: ::LCD --
1684 R42820
                MOV SBUF, #OFOH : HUNS BLANK
1687 7599F0
                 ACALL TRANS_DEL
168A D125
                MOV SBUF, #OATH :TENS "-"
168C 7599AL
168F D125
                ACALL TRANS_DEL
                 MOV SBUF . #OAZH : ONES "-"
1691 7599A2
                 ACALL TRANS_DEL
1694 D125
                 AJMP BLINK_BEEP
1696 613F
1698 00
                 NOP
                 NEW_TEMP: ::NEXT SET TEMP
                 MOV A TEMP_SET
1699 E511
                 CJNE A.#120.CALC_TEMP
169B 847805
                 MOV TEMP_SET.#40
 169E 751128
                 AJMP OFF_STATE
 16A1 C187
                 CALC_TEMP:
                 ADD A.#20
 16A3 2414
                 MOV TEMP_SET.A
 16A5 F511
                 DISPLAY_TEMP:
                 CLR G
 16A7 C3
                 RRC A :DIV BY 2
BINARY_BCD DEC_HUN.DEC_TEN.DEC_ONE
:CONVERTS BYTE LOCATED IN ACC TO DECIMAL
 1648 13
 16A9
                  AND STORES RESULT IN DEC_HUN. DEC_TEN AND ONE.
                 MOV DEC_HUN. HO ;CLEAR REGISTERS
+1649 752900
                 MOV DEC_TEN.#0
MOV DEC_ONE.#0
+16AC 752A00
+16AF 752B00
                  CALC_HUNOO11: ::SUBTRACT 100
                  A, B VOM
+1682 F5F0
                  NEXTSUB10011:
+1684 03
                  CLR C
                  SUBB A.#100
+1685 7464
+1687 4006
                  JC CALC_TENOOLL
                  INC DEC_HUN
+1689 0529
                  MOV 3.A ;SAVE
+1688 F5F0
                  SJMP NEXTSUB10011
 +1680 80F5
                  CALC_TENO011: ::SURTRACT 10
                  MOV A.8
 FIGBE ESFO
                  NEXTSUB20011:
                  CLR C
 +1601 03
 -1602 340A
                  SUBR 4.#10
```

```
JC CALC_ONEOO11
+1604 4006
               INC DEC_TEN
+1606 0524
                MOV B.A
+16C8 F5F0
                SJMP NEXTSUB20011
+16CA 80F5
                CALC_ONEOOLL:
+16CC 85F02B
                MOV DEC ONE .B
                MOV A.DEC_HUN
+16CF E529
                .TNZ BCD_OUTOOLL
F16D1 700A
                MOV DEC_HUN. #OFH :BLANK
+16D3 75220F
                MOV A.DEC_TEN
+16D6 E5ZA
+16D8 7003
                JNZ BCD_OUTOO11
                MOV DEC_TEN. #OFH :BLANK
+16DA 752AOF
                BCD_OUTOO11:
MOV_SBUF.#OFOH ;HUN_BLANK
 1600 7599FO
                ACALL TRANS_DEL
 16E0 D125
                MOV A.DEC_TEN
 16E2 E5ZA
                SWAP A
 16E4 C4
                ORL A. HOIH
 16E5 4401
                MOV TEMP_DEC.A ; SAVE TENS
 16E7 F512
                MOV SBUF.A
 16E9 F599
                 ACALL TRANS_DEL
 16EB 0125
                MOV SBUF, #02H ; ONES
 16ED 759902
                 ACALL TRANS_DEL
 16F0 D125
                 AJMP BLINK_BEEP
 16F2 613F
                 CASE1: ;:NEBULIZER HOLD
                 SETB PSW.3 :BANKI
 16F4 D2D3
                 CLR PSW.4
  16F6 C2D4
                 JBC HOLD, HOLD_OFF
  16F8 100810
                            ;HOLD FLAG
                 SETB HOLD
  16FB D208
                 SETB BEEP
  16FD D214
                              :NEB HOLD LED
                 SETB L25
  16FF 0235
                 MOV SBUF.LED2
  1701 852699
                 ACALL TRANS_DEL
  1704 D125
                 ORL P2,#011100008
                                      :OFF VALVES
  1706 43A070
1709 8008
                 SJMP HOLD _OUT
                 HOLD_OFF:
                             :HOLD FLAG
                 CLR HOLD
  170B C208
                  CLR SEEP .
  1700 C214
                            :OFF HOLD LED
                  CLR L25
  170F C235
                  MOV SBUF.LED2
  1711 852697
                  ACALL TRANS_DEL
  1714 D125
                  HOLD_OUT:
                  MOV RHOLD_TIM.#120 :R7 RESET
  1716 7F78
                  SETB WALT
  1718 D200
                  SETB L16 :WAIT LED
   171A DZ1E
                 MOV SBUF . LED1
   171C 852399
                  ACALL TRANS_DEL
  171F D125
                  MOV THREE CYCLE. #0
  1721 752F00
                  AJMP BLINK BEEP
   1724 513F
                           ::SELECT VENT
                  CASE4:
                  ORL PZ.#O11100008 :VALVES OFF
   1726 43A070
                  SETR VEN_SEL
   1729 D204
                  SETR WAIT
   1728 0200
```

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```
MOV THREE_CYCLE.#0
172D 752F00
               SETB L16 ;WAIT
1730 D21E
               MOV SBUF.LED1
1732 852399
               ACALL TRANS_DEL
1735 D125
               CLR PSW.3 :BANKO
1737 C2D3
1739 0204
               CLR PSW.4
                            ;R4. INC. VENT. NO.
               MOV A.RVENT
1738 EE
               ADD A.#10H
1730 2410
               CJNE A, #43H.SEE_VENT
173E 344302
               MOV A, #13H :RESET #1
1741 7413
               SEE_VENT:
               MOV RVENT.A
1743 FE
                                 DISPLAY NEW NUMBER
               MOV SBUF . RVENT
1744 BE99
               ACALL TRANS_DEL
1746 0125
               NOP
1748 00
                             ;LOOK UP THRESHOLDS FOR VENTILATOR SELECTED
               MOV A, RVENT
1749 EE
               SWAP A
174A C4
               ANL A. #OFH :CLEAR ADDRESS
RL A :MULT. BY 2
               ANL A. #OFH
174B 540F
174D 23
               MOV B.A ; SAVE
174E F5F0
               ACALL VENT_TBLE
1750 F15D
                MOV VENT_HI.A ;STORE UPPER THRESH
1752 F518
               MOV A.B
1754 ESFO
                DEC A
1756 14
1757 F15D
                ACALL VENT_TBLE
                                STORE LOWER THRESH
                MOV VENT_LO.A
1759 F51A
                AJMP BLINK_BEEP
175B 613F
                VENT_TBLE: MOVC A.GA+PC
175D 83
                RET : THRESHOLDS
175E 22
175F 3B 45 81
                D8 3BH.45H.81H.86H.3BH.45H ;SERVO LO 2.3V, HI 2.7V
1762 86 38 45
                ;PB7200 LO 5.05V, HI 5.25V, HAM LO 2.3V, HI 2.7V
                CASEB1: :: INITIALIZATION ENTRY
                CLR ETO
1765 CZA9
1767 0280
                CLR TRO
                        TICHANGE VOLUME
                CASEB:
                SETB VOL_CHG
1769 0203
                MOV A.CHG_VOL
 1768 E528
 176D C4
                SWAP A
 176E 23
                RL A
                MOV B.A
 176F F5F0
 1771 F18F
                ACALL CHGVOL_TBLE
                MOV SET_CHGTIM.A
 1773 F519
                MOV A.B
 1775 ESF0
 1777 14
                DEC A
                ACALL CHGVOL_TBLE
 1778 F18F
                MOV CHG_VOL.A
 1774 F529
                MOV SBUF . CHG_VOL
 1770 852899
 177F D125
                ACALL TRANS_DEL
 1781 0200
                SETB WAIT
                MOV THREE CYCLE. 40
 1783 752F00
                SETB L16
```

#### SUBSTITUTE SHEET

1786 D215

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```
MOV SBUF.LEDI
1788 852399
                ACALL TRANS_DEL
1788 D125
                AJMP BLINK_SEEP
1780 613F
                CHGVOL_TBLE: :: SELECT NEW VOL
                MOVC A. QA+PC
178F 83
1790 22
                RET
1791 20 14 40 08 20H.20,40H.40.0.0.60H.60.0.0.10H.10
1794 28 00 00 60 3C 00 00 10 0A :SHIFT TO NEW VOLUME
                           ::NO ACTION
                 CASEJ:
                 AJMP BLINK_BEEP
1790 613F
                 CASE2: :NO ACTION
                 AJMP BLINK_BEEP
179F 613F
                 CASES: :: DISPLAY TEMP
                 JBC SEE_TEMP, RESTORE_VOL1
17A1 10105B
                 SETB SEE_TEMP
CLR PSW.3 :BANKO
17A4 D210
17A6 C2D3
                 CLR PSW.4
17A8 C2D4
                 MOV A.RTEMP :RS
17AA ED
                 CLR C
17AB C3
                        :DIV BY 2
                 RRC A
17AC 13
                 BINARY_BCD DEC_HUN, DEC_TEN. DEC_ONE
;CONVERTS BYTE LOCATED IN ACC TO DECIMAL
17AD
                 AND STORES RESULT IN DEC_HUN, DEC_TEN AND ONE.
                 MOV DEC_HUN.#0 ;CLEAR REGISTERS
MOV DEC_TEN.#0
MOV DEC_ONE,#0
+17AD 752900
+1780 752A00
+17B3 752800
                 CALC_HUNO012: ::SUBTRACT 100
+1786 F5F0
                 MOV B.A
                 NEXTSUB10012:
                  CLR C
+1788 C3
                  SUBB A.#100
+1789 9464
                  JC CALC_TENO012
+1788 4006
                  INC DEC HUN :
+178D 0529
                  MOV B.A :SAVE
+178F F5F0
                  SJMP NEXTSUB10012
+17C1 BOF5
                  CALC_TENO012: ::SUBTRACT 10 MOV A.B
+1703 ESF0
                  NEXTSUB20012:
                  CLR C
+1705 C3
                  SUBB A.#10
+17C6 940A
                  JC CALC _DNEOO12
+17C8 4006
+17CA 052A
                  MOV B.A
+1700 F5F0
                  SJMP NEXTSUB20012
+17CE 90F5
                  CALC_ONEOO12:
                  MOV DEC_ONE.B
+1700 B5F02B
                  MOV A.DEC_HUN
+1703 E529
                  JNZ BCD_DUTO012
+1705 700A
+1707 75270F
                  MOV DEC_HUN. #OFH : SLANK
                  MOV A DECLIEN
 11700 E52A
```

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```
JNZ BCD_OUTOO12
+17DC 7003
                 MOV DEC_TEN. #OFH
                                     :BLANK
+17DE 752AOF
                 BCD_DUTOO12:
                 NOP
 17E1 00
                 MOV A.DEC_HUN
 17EZ E529
                 SWAP A
 17E4 C4
 17E5 F599
                 MOV SBUF.A
                 ACALL TRANS_DEL
 17E7 D125
                 MOV A, DEC_TEN
 17E9 E52A
 17EB C4
                 SWAP A
                 ORL A.#OIH
 17EC 4401
                 MOV SBUF . A
 17EE F599
                 ACALL TRANS_DEL
 17FO D125
                 MOV A, DEC_ONE
 17F2 E528
 17F4 C4
                 SWAP A
                 ORL A.#OZH
 17F5 4402
 L7F7 F599
                 MOV SBUF.A
                 LCALL TRANS_DEL
 17F9 121625
                 LJMP BLINK_BEEP
 17FC 02133F
                  RESTORE_VOL1: ::DISPLAY VOL
                  CLR PSW.3 :BANK2
 17FF C2D3
                  SETB PSW.4
 1801 D2D4
                  MOV SBUF.CHG_VOL
 1803 852899
                  LCALL TRANS_DEL
 1806 121625
                  MOV SBUF, #01H
 1809 759901
                  LCALL TRANS_DEL
 180C 121625
 180F 759902
                  MOV SBUF, #02H
                  LCALL TRANS_DEL
 1812 121625
                  OUT_TEMP:
                  LJMP BLINK_BEEP
 1815 02133F
                  CASE9: ::DISPLAY FLT LOAD
                  JBC SEE_LD .RESTORE_VOL2
 1818 101113
                  SETB SEE_LD
 1818 0211
                  MOV SBUF FLTLD HUN
 1810 852099
                  LCALL TRANS_DEL
 1820 121625
                  MOV SBUF . FLTLD_TEN
 1823 852D99
                  LCALL TRANS_DEL
 1826 121625
1829 852E99
                  MOV SBUF.FLTLD_ONE
                  AJMP OUT_DISPLD
 182C 0140
                  RESTORE_VOL2: ::DISPLAY VOL MOV SBUF, CHG_VOL
 182E 852899
                  LCALL TRANS_DEL
 1831 121625
1834 759901
                  MOV SBUF. #01H
                  LCALL TRANS_DEL
  1837 121625
                  MOV SBUF . #02H
  183A 759902
                  LCALL TRANS_DEL
  LB3D 121625
                  OUT_DISPLD:
                  LJMP BLINK BEEP
  1840 02133F
                            ::ENTER KEY
                  CASEC:
                  CLR VEN SEL CLR VOL CHG
  1843 C204
  1845 C203
                  CLR TEMP
  1847 C23R
```

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```
1849 0203
               CLR PSW.3 :BANKO
               CLR PSW.4
1848 C2D4
               MOV SBUF . RVENT
1840 BE77
               LCALL TRANS_DEL
184F 121625
               MOV SBUF, CHG_VOL : SET HUNS
1852 852899
               LCALL TRANS_DEL
1855 121625
1858 759901
               MOV SBUF, BOIH : SET TENS
               LCALL TRANS DEL
1858 121625
               MOV SBUF, #02H : SET ONES
185E 759902
               LCALL TRANS_DEL
1861 121625
1864 02133F
               LJMP BLINK_BEEP
               CASE7:
                       ::NO ACTION
1867 02133F
               LJMP BLINK_BEEP
               CASEB: :: NO ACTION
               LJMP BLINK_BEEP
186A 02133F
                       ::SIL ALM 2 MIN
               CASE6:
                SETB PSW.3 ;BANK1
1860 D2D3
               CLR PSW.4
186F C2D4
                           OFF BUZZER
1871 C2A7
                CLR P2.7
                           SILENCE FLAG
               SETB SIL :SILENCE
MOV RSIL_TIM,#120
1873 D206
                                    :R6,TWO MIN. TIMER
1875 7E78
1877 02133F
                LJMP BLINK_BEEP
                CASEA:
                         ::ALM RST
                MOV P2.#78H : OUTPUTS OFF
187A 75A078
                            CLEAR BITS
                MOV 20H,#0
1870 752000
                MOV 21H,#0
1880 752100
                MOV 22H,#0
1883 752200
1886 752700
                MOV 27H.#0
1889 0200
                SETB WAIT
                SETB LIG :WAIT
1888 D21E
               CLR L15 :FILT CHANGE
CLR L17 :LOFLOW
188D C21D
188F C21F
               MOV SBUF, LED1
1891 852399
1894 318E
                ACALL TRANS_DEL1
                MOV SBUF CHG_VOL : NORMAL LCD
1896 852899
1899 318E
1898 759901
                ACALL TRANS_DEL1
                MOV SBUF, #O1H
189E 31BE
                ACALL TRANS_DELI
18A0 759902
             MOV SBUF, #02H
                ACALL TRANS_DEL1
18A3 31BE
                CLR PSW.3
                           ;BANKO
18A5 C2D3
LBA7 C204
                CLR PSW.4
IRA9 8E99
                MOV SBUF . RVENT : R1
                ACALL TRANS_DEL1
1848 318E
                ANL LEDZ. HOFH :OFF
18AD 53260F
                MOV SBUF, LED2
 1880 852699
                ACALL TRANS_DEL1
1883 318E
                CLR L34 :HI PRESS
 1885 C22C
                MOV SBUF LED3
 LRR7 852599
1884 318E
                ACALL TRANS_DELI
               MOV THREE_CYCLE.#0 :RESET
 L88C 752F00
```

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```
SETB PSW.3 :BANKI
188F D2D3
                CLR PSW.4
18C1 C2D4
18C3 7C00
                 MOV RON_TIM.#0
                MOV ROFF_TIM. #0
18C5 7D00
18C7 755000
                MOV POSSUM. #0
                MOV NEGSUM. #0
18CA 755100
                MOV THO, #70H :RST TIMER
18CD 758C70
                MOV IE.#87H :SET ETO
MOV TCON.#50H :SET TRO
1800 75A887
1803 758850
                 RET
1806 22
                 CASED: ::DISPLAY PIP
                   :MULTIPLY BY SCALE FACTOR OF 5/8. CONVERT TO BCD :AND DISPLAY PIP. RETURN TO VOLUME DISPLAY WHEN
                   :SWITCH IS PRESSED A SECOND TIME.
                 JBC SEE_PIP.LCD_VOL
18D7 100968
                 SETB SEE_PIP
18DA D209
                 MOV A.PIP_STORE
18DC ES4E
                 MOV 8.#5
18DE 75F005
                           :MSB IN B
                 MUL AB
18E1 A4
                           :RRC 3 TIMES TO DIVIDE BY 8
                 XCH A.B
18E2 C5F0
                            :MSB IN A
18E4 13
                 RRC A
                 XCH A.B
                           :LSB IN A
18E5 CSF0
                 RRC A
18E7 13
                           :SECOND ROTATION
                 CLR C
18E8 C3
                 XCH A.B
18E9 C5F0
18EB 13
                 RRC A
                 XCH A.B
18EC CSFO
                 RRC A
18EE 13
                           :THIRD ROTATION
 18EF 03-
                 CLR C
                 XCH A.B
 18FO CSFO
 18F2 13
                 RRC A
 18F3 CSF0
                 XCH A.B
                 RRC A
 18F5 13
                 SUBB A.#14H :ZERO OFFSET
 18F6 9414
                 BINARY_BCD DEC_HUN, DEC_TEN, DEC_ONE
:CONVERTS BYTE LOCATED IN ACC TO DECIMAL
18F8
                  AND STORES RESULT IN DECHUM, DECTEN AND ONE.
                                   :CLEAR REGISTERS
                  MOV DEC_HUN.#0
+18F8 752900
                 MOV DEC TEN. #0
MOV DEC ONE, #0
+18FR 752A00
+18FE 752B00
                  CALC_HUNO013: ::SUBTRACT 100
                  A.8 VOM
+1901 F5F0
                  NEXTSUB10013:
                  CLR C
+1903 C3
                  SUB8 A.#100
+1704 9464
                  JC CALC_TENOO13
+1906 4006
                  INC DEC_HUN
+1908 0529
                           :SAVE
+190A F5F0
                  MOV B.A
                  SJMP NEXTSUBLOOLS
+190C 80F5
                  CALC_TENO013: ::SUBTRACT 10 MOV A.3
-190E ESF0
                  NEXTSUB20013:
                  CLR C
+1910 C3
```

```
SUBB A.#10
+1911 940A
                 JC CALC _ONEOO13
+1913 4006
                 INC DEC_TEN
+1915 052A
+1917 F5F0
                 MOV B.A
                 SJMP NEXTSUB20013
+1919 BOF5
                 CALC_ONEOO13:
                 MOV DEC_ONE.8
+1918 85F028
                 MOV A, DEC_HUN
+191E E529
+1920 700A
                 JNZ BCD_OUTOO13
                 MOV DEC_HUN, #OFH
                                    :BLANK
+1922 75290F
                 MOV A.DEC_TEN
+1725 E52A
                 JNZ BCD_OUTOOL3
+1927 7003
                 MOV DEC_TEN. #OFH
                                    :BLANK
+1929 75ZAOF
                 BCD_OUTOO13:
                 MOV A, DEC_HUN : DISPLAY PIP
 192C E529
                 SWAP A
 192E C4
 192F F579
                 MOV SBUF, A
                 ACALL TRANS_DEL1
 1931 318E
1933 E52A
                 MOV A.DEC_TEN
                 SWAP A
 1935 C4
                 ORL A.#OIH
 1936 4401
 1938 F599
                 MOV SBUF.A
                 ACALL TRANS_DELI
 193A 318E
193C E528
                 MOV A.DEC_ONE
                  SWAP A
 193E C4
                 DRL A.#02H
 193F 4402
 1941 F599
                  MOV SBUF, A
                  SJMP OUTPIP
 1943 800D
                  LCD_VOL: ::DISPLAY VOL
                  MOV SBUF . CHG_VOL
 1945 852899
                  ACALL TRANS_DEL1
 1948 31BE
 194A 759901
                  MOV SBUF, #01H
                  ACALL TRANS_DEL1
 194D 31BE
194F 759902
                  MOV SBUF. #02H
                  OUTPIP:
                  LJMP BLINK_BEEP
  1952 02133F
                  CASEE: ::ALM TEST
                  : PUSH SW TO TEST & PUSH TO RETURN
                  JBC ALM_TST.NORMAL
  1955 100A33
                  SETB ALM_TST
SETB P2.7
  1958 D20A
                               ON BUZZER
  195A DZA7
  195C 7480
195E F599
                  HOV A. #BOH
                  MOV SBUF, A ; HUNS LCD TEST
                  LCALL TRANS_DELI
  1960 1219BE
  1963 04
                  INC A
                  MOV SBUF.A
  1964 F599
                  LCALL TRANS_DELI
  1966 1219BE
                               :ONES
  1969 04
                  INC A
                  MOV SBUF.A
  196A F599
                  LCALL TRANS_DELL
  196C 1219BE
                               :VENT #
  196F 04
                  INC A
                  MOV SBUF.A
  1970 F599
  1972 12198E
1975 74F4
                  LCALL TRANS DELL
                  MOV A. #OF4H : LEDI TEST
```

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```
MOV SBUF . A
1977 F539
                LCALL TRANS_DELI
1979 12198E
                INC A :LED2
1970 04
1970 F599
                MOV SBUF.A
                LCALL TRANS_DEL1
197F 1219BE
                INC A
1982 04
                MOV SBUF, A ; LED3
1983 F599
                LCALL TRANS_DELI
1985 1219BE
                LJMP OUT_TST
1988 02198A
                NORMAL: ::NORMAL DISPLAY
CLR P2.7 :RESTORE ALARM & DISPLAYS
1988 CZA7
                           :BANKO
                CLR PSW.3
1980 C2D3
                CLR PSW.4
198F CZD4
                MOV SBUF, CHG_VOL
1991 852899
                LCALL TRANS_DEL1
1994 1219BE
1997 759901
                MOV SBUF, #01H
                LCALL TRANS_DELI
199A 1219BE
                MOV SBUF. #02H
1990 759902
1940 12198E
                LCALL TRANS_DELI
                 MOV SBUF , RVENT
19A3 8E99
                LCALL TRANS_DELI
19A5 1219BE
                MOV SBUF, LED1
19A8 852399
                 LCALL TRANS_DEL1
19A8 1219BE
                 MOV SBUF.LED2
 19AE 852699
                 LCALL TRANS_DELI
1981 12198E
                 MOV SBUF.LED3
 1984 852599
 1987 12198E
                 LCALL TRANS_DEL1
                 OUT_TST:
                 LJMP BLINK_BEEP
 198A 02133F
                 NOP
 1980 00
                 TRANS_DEL1: ;:DELAY 2.25MS.CC=80EH
                 DJNZ DIVIDE1.TRANS_DEL1 ; COUNT 255
 198E DSIDFD
                 MOV DIVIDE1, #OFFH :RESET
 19C1 7510FF
                 DJNZ DIVIDEZ.TRANS_DEL1 :COUNT 4
 19C4 DS1EF7
19C7 751E04
                 MOV DIVIDE2.#04H :RESET
 19CA 22
                 RET
                 NOP
 1908 00
                 MAN_SW: :: ON VALVES
                 PUSH ACC
 L9CC COEO
                 PUSH PSW
 LICE CODO
                 CLR EXO : DISABLE INT
 1900 C2A8
                 ANL P2.#10001111B :ON VALVES
 1902 53A08F
                 HOLDIT: LCALL SERVICE
 1905 12156E
                 JNB P3.2.HOLDIT
 1908 3082FA
 1908 0200
                 SETB WAIT
                           :WAIT LED
 1900 D21E
                 SETB L16
                 MOV SBUF.LEDI
 190F 852399
                 ACALL TRANS_DELI
 19E2 31BE
                 ORL P2.#01110000B : OFF VALVES
 19E4 43A070
                 MOV THREE_CYCLE. #OOH
 19E7 752F00
                 SETB EXO : ENABLE INTO
 LREA DZAB
                 POP PSW
 LIEC DODO
                 POP ACC
 LAEE DOED
```

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RETI 19F0 32

; \*E

ENDS : CODE SEGMENT END BEGIN 19F1

1000

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AWP_LC							•	•	•		•	•	•	-		D	C	040	)
BANKO				•	•	•	•	•	•		•					U	O	000	)
BCD O				•	•		•	•	•		•	•	-			Ĺ	1	600	)
800.00	.,	2	O 1.		•	•	•	•	•		•	•		•		Ĺ	1	7E	ı
BCD_O	J 1	2	01.	<u>-</u>	•		•	•	•		•	•	•			Ĺ	1	920	2
8CD_0							•	•	•		•	•	•	•	•	8	C	001	4
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BLINK		Ε	EP	•	•	٠	٠	-	•		•	•	•		:	L		162	
BLINK	_8	Ε	EΡ	ι	•	٠	•	٠	•		٠	•	•	•	•	L	_	168	-
CALC_	HI,	M	00	11	-	•	•		•		•	٠	•	٠	•	L	_	178	
CALC	HU.	N	00	12		٠	٠		•		•	•	٠	•	•			190	
CALC	HI.	N	00	13		•	٠	٠		•	•	•	•	•	•	Ļ		1 6C	
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CALC	ON	ΙE	00	13	•						•	•	•	•	•	Ļ		191	_
CALC	PĮ	P	٠.								•	•	•	•	•	L		115	
CALC	TE	M	9								•	•	•	•	•	L		16A	_
CALC	TE	'N	OO	11								-		•	•	L		16B	
CALC	TE	N	00	12	2.					-		-		•	•	L.	•	17C	_
CALC	T E	ĒΝ	00	13	5.							-	•	-	-	L		190	
CASE										-			•		•	L	-	167	_
CASE				_												Ļ		16F	
CASE2		•	-			_	_									Ļ		179	F
CASE		•	•	:	Ī.	_										Ų		179	O
CASE			•	•	•	•										ι		172	26
CASES			•	•	•	•	•					_						176	14
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CASE			•	٠	•	•	•		•	:	•			_	•	: 1	_	165	5D
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CASE		•	-	•	-	•	•	•	•	•	•	•	•	·			Ĺ	176	59
CASE	_	•	•	•	•	•	•	•	•	•	•	•	•	٠			Ī	176	
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CASE				٠		•		•	•	•	•	٠		•		-	L	18	
CASE			•			•		•	٠	•	•	-	•			•	L	160	
CASE		•	-	-	•		•	•	•	٠	•	•	•	•			L	180	
CASE		-	-	•	-		•	-	•	٠	٠	•	•	-		•	L	16	_
CASE			•				•	-		•	-	•	•	•	•		L	18	_
CASE	_		-	٠	-		•	-	•	•	•	٠	-	•	•	-	_	16	_
CASE			٠				•	-	•	٠	-	•	•		•		L	18	
CASE							-	•	•	•	-	•	•		•	-	L	16	_
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CASE	Ξ1.														L	1679
CASE	F.														L	165A
CHAR	GE														L	1184
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CHG .	VOI	•		_	-			Ĭ.	Ċ		-		·	-	D	0028
CHK_					:					٠	•	•	•		Ĺ	1107
CHK_	,-n-		Тм	•						•	•	•	•	:	ī	11E6
CHK_								•	•	•	•	•	•	•	Ĺ	1242
								•	•	•	•	•	•	•	-	
CHK	.EUE		3.	•	-		•	•	٠	•	•	•	•	•	L	12A7
CHK_							•	٠	٠	•	٠	-	•	-	L	123F
CHK_							•	•	•	•	•	•	•	•	L	1100
CHK_				•			•	•	•	•	•	•	•	•	L	1429
CHK.				-		•			•	•	•	•	•.	•	L	1328
CHK_					•	-	-	•	•	•	•	•	-	-	L	13A9
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HOLD_OU	Τ.	-		-	•	-				•	•	-			
INC3.	:			-			-	-		•	-	•	L		1336
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NEGFLO											•	•	•	٢	
NEGSUM												•	•	D	0051
NEW TE													•	L	1699
NEXT10														l_	1160
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NEXT10002	2									•	•	•	•	_	1209
NEXT10004	1 .								-		•		•	L	145D
NEXT10006	5													L	1486
NEXT10008														L	14EF
NEXT2000	-													L	1185
NEXT2000		•												L	12E1
NEXT2000		•												L	1474
NEXT2000														L	1480
NEXT20008								•						Ĺ	1506
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NEXTSUB 1	20		•	•	•			•	•	:	:		•	Ĺ	1788
NEXTSUB1						-		•	:	•	:	-	:	ī	1903
NEXTSUB1								•		•	•	•	•	Ē	16C1
NEXTSUB2						•	•	•	-	•		:	•	Ĺ	17C5
NEXTSUB2					•	•	•	•	-	•				L	1910
NEXTSUB2							•	-	•	•	•	•	•	-	1524
NEXT_SAM	P	•	•	•			•	•	•	-	•	•	•	Ļ	
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NOFLO_AL	M		-									•	•	L	15F7
NOFLO_TH										•	-	-	-	I	008C
NORMAL.										-	-		•	L	1988
NOT_EQ.	_										-			L	1587
OFFTIMER														D	0015
OFF_ALM														8	000D
OFF_STAT	Ė	•					•		_		_			L	1687
ONTIMER						•	•							D	0014
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PEEP_AVE	<b>;</b> .						•		•	-	-	-	•	D	_
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RESTORE		٦L	2	•	-	٠	•	•	•	•	•	-			
RETURN.				•	•	٠	•	•	•	•	•	•			
RFLT_FL				•			•	•	•	•	•	•			
RHOLD_T						-	•	•	•	•	•	•			2 0007
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RON_TIM									-						R 0004
RSIL_TT															R 0006
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RVENT_SIG				_	_							R	0001
SAMPLE.					_		_					L	1435
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SERVICE	•			:	:		•	-				Ĺ	156E
SERVICE . SET_CHGTIM	•	•	•		:	:	:					Ď	0019
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SW_OFF							•	:		•	•	В	003B
TEMP	•		•	•		•	•	:		•	:	L	1573
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TEST25			•	-	•	•	•	•	•	•	•	Ļ	1286
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TEST75 THREE_CYCL	•		•	•	•	•	•	•	•	•	•	Ļ	1258
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TIM_SAMP.			•		•	•	•		•	٠	•	L	13F3
TRANS_DEL					-	•	•	•	•	•	•	L	1625
TRANS_DEL1				-	•	•	٠	•	•	•	•	Ļ	198E
TST_BEEP1	•		•	-		•			•	-	•	L	1394
TST_BEEP2	•		•	-	-			•	•	•	•	L	
TST_TEMP1			•	-	•	•	•		•		•	Ļ	1387
TST_TEMP2 TST_VENTSE				•	•	•		-	•	•	•	L	1309
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TST_VENTSE	L2			-	-			-	•	•		L	13D1
TURN_OFF.				-				-	•			L	139E
TURN_ON .	-								-		-	L	134E
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#### WHAT IS CLAIMED IS:

A nebulizer comprising:

a housing containing a reservoir for holding a liquid to be nebulized and an air space above the reservoir for holding aerosol;

means for generating said aerosol by nebulizing said liquid;

means for attaching said housing to a mechanical respirator having an inhalation phase, an exhalation phase, a gas flow passageway to a patient, and an external electrical signal source capable of generating a first electrical signal during said exhalation phase;

means responsive to said first electrical signal for introducing said aerosol into said gas flow passageway, such that said aerosol fills said gas flow passageway during a portion of said exhalation phase.

- 2. The nebulizer of Claim 1 further comprising means for monitoring the amount of said aerosol introduced into said gas flow passageway.
  - 3. The nebulizer of Claim 1 wherein said mechanical respirator further being capable of generating a second electrical signal during said inhalation phase.
  - 4. The nebulizer of Claim 3 wherein said aerosol generating means further comprising a plurality of nebulizer nozzles each having means for controlling the gas flow therethrough.

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5. The nebulizer of Claim 4, wherein said introducing means further comprises:

a gas flow for directing compressed gas from a compressed gas source to each of said plurality of controlling means for said nebulizer nozzles; said gas flow means including means responsive to said first electrical signal for opening a conduit of said nebulizer nozzles and for closing the conduit to said nebulizer nozzles simultaneously or one at a time, in response to said second electrical signal.

6. The nebulizer of Claim 5 further comprising:

means responsive to said second electrical signal for generating a decreasing flow of gas; and

means for directing said decreasing flow of gas into said mechanical respirator.

7. A method of operating a nebulizer of the type having means for generating an aerosol and means for supplying said aerosol to a mechanical respirator having an inhalation phase, an exhalation phase and a gas passageway to a patient, and an external electrical signal source capable of generating a first electrical signal during said exhalation phase, method comprising:

generating said aerosol; and introducing said aerosol into said gas passageway during a portion or all of the said exhalation phase.

8. The method of Claim 7 wherein said introducing step further comprising:

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opening a valve, in response to said first signal, to introduce said aerosol from said nebulizer to said gas passageway.

9. The method of Claim 7 wherein said generating step further comprises:

entraining a liquid into a source of compressed gas to generate said aerosol, in response to said first signal and continuing until standardized volume of aerosol dose has been delivered.

- 10. The method of Claim 7 wherein said external electrical signal source is capable of generating a second electrical signal during said inhalation phase.
- 11. The method of Claim 10 further comprising: ceasing the generation of said aerosol in response to said second electrical signal.
- A nebulizer for use with a respirator means having an inhalation phase and an exhalation phase, a 20 first tubing means connecting said respirator means with a patient wherein during said inhalation phase said respirator means is fluidically connected to said patient through said first tubing means for introducing breathing gas in said first tubing means 25 into respiratory tract of the said patient, a second tubing means connecting said respirator means with said patient wherein during said exhalation phase said respirator means is fluidically connected to said patient through said second tubing means for 30 receiving exhaled gas from said patient to said respirator means, said respirator means further

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having means for generating a first electrical signal during said exhalation phase; said nebulizer comprising:

means for generating an aerosol;

aerosol connecting means for connecting said generating means to said first tubing means; and

means for introducing said aerosol into said first tubing means in response to and synchronized with said first electrical signal.

13. The nebulizer of Claim 12 further comprising:

housing means containing a reservoir for holding a liquid to be nebulized and an air space above the reservoir for holding said aerosol.

- 14. The nebulizer of Claim 13 wherein said aerosol connecting means connects said air space to said first tubing means.
- 15. The nebulizer of Claim 14 wherein said generating means comprising:

a plurality of nebulizing nozzles each having means for controlling the gas flow therethrough.

- 16. The nebulizer of Claim 15 wherein said respirator means for generating a second electrical signal during said inhalation phase.
- 17. The nebulizer of Claim 16 wherein said introducing means for all of said nebulizing nozzles, in response to said first electrical signal, de-

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activates said controlling means, either simultaneously or one at a time.

- 18. The nebulizer of Claim 14 further comprising means for monitoring said aerosol introduced into said first tubing means.
- 19. The nebulizer of Claim 16 further comprising:

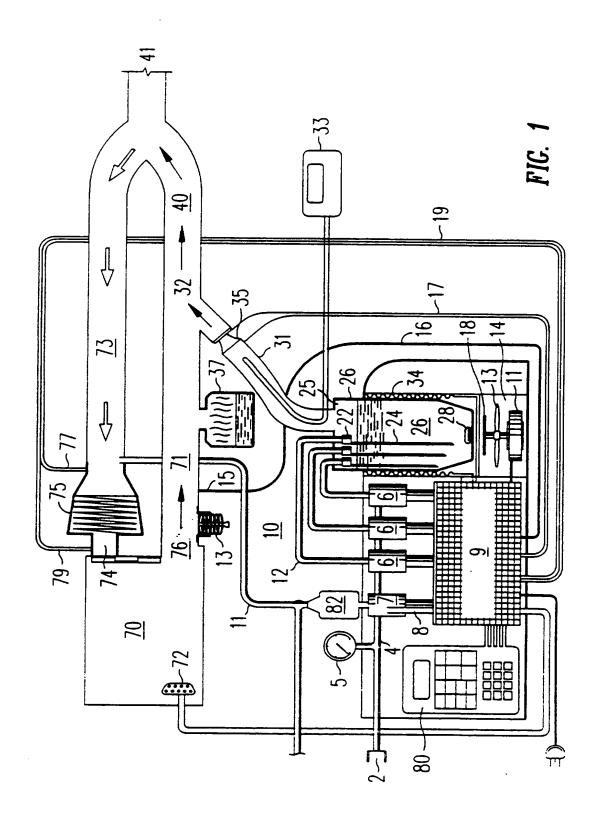
means for generating a decreasing flow of gas; and

means for directing said decreasing volume of gas into said second tubing means.

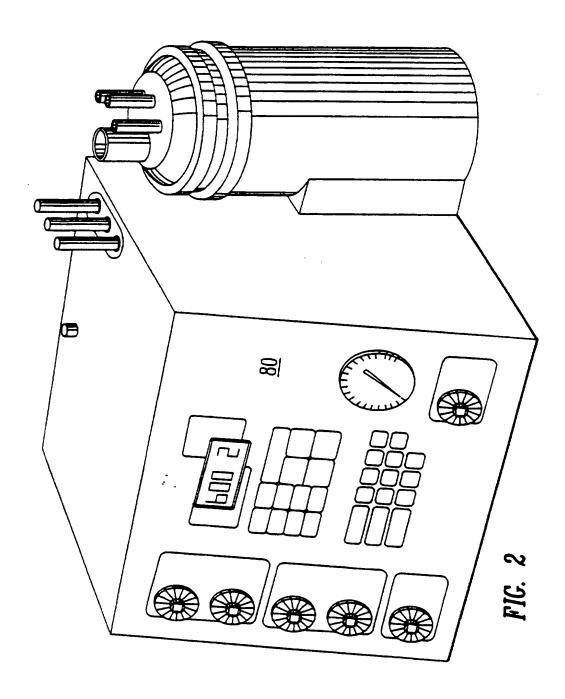
- 20. The nebulizer of Claim 12 wherein said means for generating said first electrical signal further comprises:
- a filter pressure sensor for detecting the pressure differential in said second tubing means, and for generating a filter pressure signal in response thereto;

an airway pressure sensor for detecting the pressure in said first tubing means, and for generating an airway pressure signal in response thereto; and

means for receiving said filter pressure signal and said airway pressure signal and for generating said first electrical signal synchronized with the commencement of said exhalation phase.



SUBSTITUTE SHEET



# INTERNATIONAL SEARCH REPORT PCT/US92/00566

		International Application No. PCT/	3392700366
1. CLASSIFICATIO	N OF SUBJECT MATTER (if several class	ification symbols apply, indicate all) 6	
U.S. Cl.	A61M 15/00, A61M 16/10 128/203.12, 204.21, 204.	tional Classification and IPC ,A62B 7/00, F16K 31/02 23. 204.26	
II. FIELDS SEARCH			
		ntation Searched ?	
Classification System		Classification Symbols	
U.S.	128/200 14, 200.21, 203.1	12 203 13 203 14 203	16 202 17
	203.26, 203.27, 204.17, 2	204.18, 204.21, 204.23,	204.26
	Documentation Searched other to the Extent that such Documents	than Minimum Documentation s are included in the Fields Searched <sup>8</sup>	
III. DOCUMENTS C	ONSIDERED TO BE RELEVANT		
Category * Citati	on of Document, $^{11}$ with indication, where app	propriate, of the relevant passages 12	Relevant to Claim No. 13-
Y US, A,	4,106,503 (ROSENTHAL See entire document	et al) 15 AUGUST 1978	1-3,7-14,18-20
Y US, A,	4,832,014 (PERKINS) See entire document	23 MAY 1989	1-3,7-14,18-20
Y US, A,	4,197,843 (BIRD) See entire document	15 APRIL 1980	1-3,7-14,18-20
Y US, A,	RESPIRATORY THERAPY EQ (MCPHERSON) @1985, C.V 128-131, 158-163, 468-	MOSBY CO pp.	1-3,7-14,18-20
"A" document defini considered to b "E" earlier documen filing date "L" document which	of cited documents: **  ng the general state of the art which is not e of particular relevance t but published on or after the international may throw doubts on priority claim(s) or	"T" later document published after to or priority date and not in conficited to understand the principl invention. "X" document of particular relevant cannot be considered noval or involve an inventive stap.	ict with the application but ie or theory underlying the ce; the claimed invention
citation or other "O" document referr other means	D establish the publication date of another special reason (as specified) ing to an oral disclosure, use, exhibition or the prior to the international filing date but	"Y" document of particular relevan cannot be considered to involve document is combined with one ments, such combination being in the art.	an inventive step when the or more other such docu-
later than the pr	iority date claimed	"4" document member of the same	patent family
Date of the Actual Cor 27 APRIL 19	npletion of the International Search	Date of 200 all Affining Charges Se	earch Report
International Searching	Authority	Signature of Authorized Officer KIMBERLY L. ASHER	again by